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CONSERVATION OF OIL*

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Ladies and Gentlemen, we in the oil business recognize the importance of giving opinion leaders more information about our industry. We want them to know that the oil industry is doing a good job in supplying the oil this nation needs—and at the same time is conserving our natural resources to make the greatest possible amount of oil available in the years to come.

First, let's take a look at the position of oil in our national economy. Nearly half of the energy used in America these days comes from oil. It powers our cars, trucks, busses and planes. Many of our trains and ships are oil-powered. Oil heats millions of our homes. It lubricates the wheels of industry. Oil, coal and steel are the foundation blocks in our industrial civilization.

Each day, America uses nearly six million barrels of oil, or, in other words, about 250 million gallons of oil. That much oil would fill 25,000 railroad tank cars. The demand for oil is nearly double now what it was just ten years ago. In ten years, for example, the number of oil burners in use has more than doubled and the number of cars has gone up nearly fifty per cent.

Our need for oil in wartime is even greater. Secretary of Defense Forrestal has recently estimated that one-third more oil would be needed daily if we were involved in another war.

Having established that we need oil, let's think for a minute about what it is, where it came from, and where we find it.

The dictionary says that "petroleum" is: "an oily, inflammable liquid, almost colorless to black but usually of a dark brown or green-

* Read at the Conservation Group Meeting of the Annual Meeting of the Central Association of Science and Mathematics Teachers at Indianapolis, Saturday, November 27, 1948.

ish hue, existing at many places in the upper strata of the earth. It is essentially a complex mixture of hydrocarbons with small quantities of other materials such as sulfur, nitrogen compounds, water and silica."

Most geologists will agree that oil probably was formed from marine life deposited at the bottom of ancient seas millions of years ago. But when you ask them how the marine life was converted to oil, they say they are not certain. A lot of research is being done to find out how oil was made.

Oil and the gas formed with it are lighter than water, so there was a tendency for them to move upward through the earth's crust toward the surface. When this upward journey was stopped by a layer of non-porous rock, an oil pool or reservoir resulted. We find our oil in these geological traps.

Responsible geologists and engineers in the petroleum industry have estimated that ultimately as much as 140 billion barrels of oil can be produced in the United States, including deposits under the water just off-shore on the continental shelf. Of this amount, 37 billion barrels had been produced to the first of this year, 25 billion barrels are in fairly definitely known reserves, and another 12 billion barrels are considered to be in semi-proved reserves. This leaves about 66 billion barrels yet to be discovered in the U. S.

But there are also tremendous oil reserves in other parts of the world.

Oil must be considered as an irreplaceable natural resource. It is available in great quantity, but it cannot be wasted. Ultimately we may have to look to coal, atomic energy or sunlight as our principal energy sources. But we can expect that in the lifetime of all of us in this room, oil will continue to be one of our major energy sources.

The American oil industry is thoroughly convinced of the necessity for conserving our oil resources. By conserving them, I don't mean shutting in the wells and leaving the oil in the ground. I mean getting the greatest possible amount of oil out of each reservoir.

Let's try to get a picture of what happens down in one of these oil pools or reservoirs.

In simple terms, a reservoir is a body of porous rock covered by a layer of non-porous rock which has trapped the oil and gas. The oil and gas accumulate in pores, cracks and crevices. You have all seen sandstone but probably few of you ever realized that sandstone in some cases contains accumulations of oil. Such accumulations are also found in limestone and dolomite rocks. The rock is typically about four-fifths solids and one-fifth pore space. Three fluids are usually present: oil, gas and water. They are usually under very high

pressure. At 5,000 feet below the surface, the pressure often is as much as 2,500 pounds per square inch.

Because of their respective densities, we usually find that the free gas is nearer the surface, the oil is deeper (usually with gas dissolved in it) and the water is the deepest of the three fluids in the reservoir.

When a well is drilled into the reservoir, it opens up a channel for the escape of oil, gas and water to the surface driven by reservoir pressure. When the reservoir pressure is great enough, it will force the fluids to the surface—just as in an artesian water well. When it is not, we must artificially lift the fluids.

For many years, the oil industry had only a vague understanding of the mechanism by which oil moved from the reservoir rock into the well bore. In relatively recent years, we have learned a great deal more about it.

Probably the simplest type of oil reservoir is that called "volumetrically controlled." The only forces at work to move the oil through the rock to the well bore are the release of gas from solution and the expansion of the oil as the pressure is decreased. If these are the only energy sources, not more than 25 per cent of the oil in the reservoir will ever be produced. Now that we understand reservoir mechanics, we know how to produce more oil by injecting gas or water under high pressure into these reservoirs.

Another common type of reservoir is the water-drive reservoir. Here the oil is in contact with water under hydrostatic pressure. As the oil is produced, water moves in to take its place. Water drive reservoirs are of two types. The edge water drive in which water encroaches down structure as the oil is produced, and the second type—the bottom water drive—where the water level rises from below as the oil is produced.

Water drive is more efficient than gas in displacing oil, but only if the producing rates are limited to the rate at which the water can move in to take the oil's place. Too high a rate of production may cause the water to encroach unevenly, trapping off some of the oil behind the water so that it can never be economically recovered This condition is called "water coning" and happens when oil is produced too rapidly.

The third type of reservoir is the gas cap type. In this type of reservoir the oil is forced into the well bore by the expansion of the gas cap. Sometimes we find a gas cap drive combined with a water drive. Properly handled, this can give us a very efficient sweep of almost all the oil present. But even then we have to be careful since gas coning can isolate oil just as water coning does.

Now that we have learned more about the way reservoirs operate,

we often help nature along through so-called "secondary recovery" operations. In the East Texas field—which is America's most prolific oil field—we are putting water back into the reservoir to supplement the natural water drive. Under this program, water produced with the oil is injected lower on the structure to supplement the natural drive. The reservoir pressure is maintained at a point which we believe will yield a considerable increase in the amount of oil eventually produced. Ultimately we expect to produce about 85 per cent of all of the original oil in the field.

Other water-flooding operations of this type are going on all through the oil-producing states. Most of them are carried out in the older and relatively shallow fields of Pennsylvania, New York, Kansas and Oklahoma.

But you will remember that we talked about two kinds of drives: *water* and *gas*. There are now many fields where gas produced along with the oil is being injected back into the reservoir under high pressures so that it can drive out more oil. Usually these gas injection programs are operated in connection with a natural gasoline plant. Here is how they work:

The "wet" gas produced with the oil is often rich in propane, butane and hydrocarbons in the gasoline range. In natural gasoline plants pressure or an extracting oil are used to recover these hydrocarbons from the gas. The "dry" gas can then be moved to market by pipeline or injected back into the field. It takes an individual study of each reservoir to determine whether gas injection will increase production. These projects require much intricate engineering; they cost a lot of money and there are often legal hurdles to overcome. This part of our conservation work has had a strong beginning, but there is still much to do.

One of our big problems has been the legal one. Under law, the minerals under a piece of land belong to the land. Thus the rights to oil in any oil field may belong to many different people or companies. Engineering studies may show that a particular field would be best operated if all of the oil were produced from the Jones lease and none from the Smith lease. But Smith owns the oil under his lease. In many states, the answer to this perplexing problem is "unitization."

Under a unitized plan of operation, the various interest holders or operators in a field agree to operate the field as a single unit. Usually they select a single company to operate the whole field. The field is then run like one large lease with the costs and the production being shared according to participation in the unit. This usually results in more efficient production, greater production and less cost of operation. Oil is produced according to one overall engineering plan.

But there are many problems in setting up units. First, not all states have satisfactory laws encouraging the establishment of units. Often a few property owners in the field will obstruct negotiations in an effort to secure for themselves an unfair advantage.

State governments and the Interstate Oil Compact have made great progress in educating people on the necessity for oil conservation, and most states have markedly improved their conservation laws in the past few years.

Some states, like Oklahoma, now have laws under which a state commission can force the establishment of a unit if a sufficient percentage of the operators in the field agree to an equitable plan and the non-signers are, in the opinion of the commission, given equitable treatment.

Thus, we see that the oil industry has learned a lot about the mechanics of oil reservoirs and that it is applying that ever-increasing knowledge to the desire to move oil more efficiently. Let's take a look now at the economic side of this picture.

American oil companies are "sold" on conservation—not only because it is the right and proper thing to do, but also because these oil companies have a real economic interest in it. Every extra barrel of oil that we can produce from a field we already have discovered is a barrel of oil we don't have to find someplace else—at a considerable cost for finding it. The whole oil industry depends upon a steady supply of oil in ample amounts to meet the demand. If we can't find and produce oil, we are out of business.

Finding oil and developing oil fields is very costly. Setting up these conservation projects, such as water-flooding or gas injection, can be very expensive, too. But almost always a well-planned conservation program yields additional oil more cheaply than it costs to find new oil reservoirs.

For a moment I would like to review some of the steps in finding oil reservoirs.

Many of the fields have been found through surface geology. By mapping surface formations, geologists are able to locate potential places where oil might have accumulated. But often the position of the underground formations has been obscured by later surface deposits. These can usually be mapped by geophysical instruments such as the seismograph. This is how the seismograph works:

Vibrations from a dynamite blast travel down through the earth and are partially reflected back by different rock layers. Reflected vibrations are detected by microphones and recorded on photographic film. The depth of reflecting layers is determined by measuring the time for the vibrations to go down and back. From the depth

at various points, a map can be drawn to show the shape of the layers.

Sub-surface maps can also be made by mapping minute changes in the earth's gravity or magnetic field caused by the formations underneath. Geologists use all this information along with data from wells already drilled in figuring out where oil *might be*. But only drilling will prove oil is there.

Two methods of drilling are used in drilling oil wells— the cable tool method and the rotary method.

The cable tool method is not used much any more. Essentially, it drills by pounding a hole in the rock formations. A heavy steel bit (shaped like a chisel) on the end of a wire cable does the pounding. The bit is raised a few feet and then dropped on the bottom. Periodically the bit is hoisted out of the hole, and a "bailer" is lowered in to remove the drill cuttings.

The rotary method of drilling is a more recent development and is used in drilling deep, as well as shallow, wells. In drilling with a rotary rig, the rock is penetrated by steadily applying weight to a rotating bit. The rock is reduced to small pieces by the scraping or grinding action of the bit. The bit is attached to a hollow string of drill pipe. The weight and rotational action are applied to the bit by the drill pipe. Drilling mud is pumped through the hollow drill pipe and returns to the surface carrying the rock particles from the hole. Engines or motors at the surface provide the power. The engines used include Diesel, butane, gas, and gasoline-driven types. Some rigs are powered by electrical motors. "Slush pumps" circulate the drilling mud, and "draw works" are the hoisting equipment for raising and lowering the heavy drill pipe string. The drill pipe is rotated by the "rotary table" on the rig floor.

Let's look at some of the costs involved in finding new oil pools. A wildcat well usually costs more than $100,000 in addition to the tens of thousands of dollars spent for leasing and mapping the land. A wildcat well is one drilled in new territory or to untested sands in a producing field. Even using the best scientific techniques, my company finds that *seven out of ten* of the wildcat wells it drills are *dry*— that is, just 30 per cent produce. The industry average is even worse. Only 18 out of every 100 wildcat wells drilled are commercial producers of oil and gas—82 dry holes.

We are still finding new oil fields, but they are getting harder to find. Often we now find new production by drilling to great depths (where a well may cost over a half million dollars). Or we find it by drilling in inaccessible places such as in mountainous country or out in the waters of the Gulf of Mexico. Building a road to a mountain

location may cost more than $100,000. And some companies have spent more than a million dollars building a "platform" out in the waters of the Gulf of Mexico for an offshore well. And that's before a dollar is spent on actual drilling of the wells. There will be some million-dollar "dry holes" out in the water.

And once you find a reservoir, more hundreds of thousands must be spent drilling the pattern of wells to produce the oil. These days, my company finds that it costs an average of $72,000 to drill a well. Pumping equipment, tank batteries, gathering lines and other equipment add to the monumental cost of developing a producing oil field.

This oil producing business is fiercely competitive. The company smart enough and lucky enough to get the leases over a good oil pool has a rich prize. When one company makes a discovery well in an area, immediately other companies begin bidding hotly for acreage with the right to drill in the vicinity. Sales of oil leases on state lands bring spirited bidding, with many companies seeking to buy leases on promising or proved structures.

And the independent operator still does well, too. Many companies had passed up the huge East Texas oil field because they did not believe geological conditions were right. An independent operator drilled the discovery well. Many of the major fields have been discovered by independent wildcatters who gambled on structures that others had passed by.

Over and over again, the competitive nature of the business has benefited the nation. Had the government been running the industry, I doubt that the East Texas field would yet be found. Most of the "experts" had said there wasn't any oil there. No bureau man, fearful for his next congressional appropriation, would dare take risks like that. Many men with many ideas and considerable foresight and courage have found oil.

And the American oil industry excels that in any other country in the world. Mexico, just to the south of the rich Texas oil fields and with rich prospects of her own, decided to take over the oil business rather than have foreign companies operate the fields for profit. Today, Mexican production is less than it was in the 'Thirties and the government is negotiating with American companies to come back in and develop Mexican oil. Most authorities agree that Russia has potential oil reserves greater than those of the United States. And yet Russia's development of her oil resources has lagged so much that Russian production today is but one-tenth that of the United States. Rumanian oil—developed by American companies—was one of the war prizes Russia sought.

Just as they have taken the lead in developing the methods for

exploring and drilling for oil, the American oil companies are leading in the development of ways to get more oil from each reservoir. By using the best conservation methods, the greatest possible amount of oil is recovered from each reservoir. This benefits the landowner and those who invest their savings in the oil business. It also assures the greatest possible amount of petroleum products for you and the other American consumers and contributes to the security of the nation.

CARL F. HANSKE
1892–1948

Carl F. Hanske, head of the science department of Manual Training High School, Indianapolis, had taught at Manual for thirty years. He was fitted by character and talents for this work, being industrious, thorough, systematic, and given to illuminating his subject by apt drawings. During his service at Manual he rarely missed a meeting of the Central Association of Science and Mathematics Teachers. He liked people and was devoted to the improvement of education.

Mr. Hanske was 56 at the time of his death, Nov. 27, following an operation. Besides being a competent teacher, administrator, artist, and photographer for the school paper, he served in many offices of leadership in education in Indianapolis and Indiana. He was president of the Indiana Association of Chemistry and Physics Teachers in 1947. In the Central Association he had served on many important committees. He had been treasurer and vice-president of the Federation of Indianapolis Public School Teachers.

Mr. Hanske graduated from Ripon College, Ripon, Wisconsin and became principal of Menominee High School. He left this position to serve in the First World War where he was assigned to the investigation of the effects of poison gas on animal tissue. Following the close of the War he joined the faculty at Manual in 1919. Later he received the Master's Degree in Education from the University of Wisconsin. For a number of years he taught biology at the Summer sessions of the Culver Military Academy and for two years he directed the night courses at Manual Training High School. He was a member of the Phi Delta Kappa scholastic fraternity. He is survived by his wife, Mrs. Lillian King Hanske, an infant daughter, Melitta Ann, and a sister, Mrs. E. J. Arps of Oshkosh, Wisconsin.

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MINIMUM MATHEMATICAL PREPARATION FOR VARIOUS COLLEGE CURRICULA*

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Since the dawn of written history mathematics has occupied an important place in education. Legend has it that over the entrance to the academy of Plato was inscribed the words: "Let no one ignorant of Geometry enter here." Those words are not carved over the door of a college building, yet during much of the time since Plato an equivalent expression has been written into the entrance conditions of our institutions of higher learning. Probably at no time in history has mathematics been studied by more people than at present.

Today, when mathematics is studied by more people than ever before, and at a time when mathematics is more important than ever before for the very existence of our culture and way of life, we are confronted with the phenomenon of having mathematics slowly but steadily crowded out of the curriculum of our high schools in America by other subjects of less fundamental character.

This movement to relegate mathematics to a minor role in the secondary schools has accompanied the increase in high school enrollments. The change in enrollment was most rapid in the period following World War I. It was a result of a number of social changes. Only part of the increase was due to a demand for more education for more people. Part of the increase in enrollment was due to the change from an agricultural economy to an industrial one. Part of the change was undoubtedly due to the conditions of labor in cities, especially during the early years of the depression.

With the increase in numbers came the demand for vocational and technical courses. At the same time there came the realization that a large part of the increased number of students could not, or at least did not, do satisfactory work in the traditional courses. One solution of the problem that could have been tried at that time would have been the creation of separate schools of a different kind. That is the way a number of European countries tried to solve a similar problem. A very select group was admitted to the Gymnasia of Germany, the Elysee of France, and the secondary schools of England. The majority could at best hope for a technical education to fit them for positions as skilled workers. That solution was rejected in America as not proper in a Democracy. Any attempt today to set up such di-

* Read at the Senior High School Group Meeting of the Central Association of Science and Mathematics Teachers at Indianapolis, November 27, 1948.

vision of schools would be bitterly opposed, not on the grounds of efficiency but because of the social implications.

The problems which have arisen from our attempt to instruct all the youth in one school system have been especially acute in mathematics. With increased enrollments in Algebra and Geometry came a sharp rise in the percentage of failures. In turn, irate parents came to school and talked with the Principal. Next, the Principal invited the mathematics teacher in for a conference. Within a very few years there was a definite lowering of standards for passing in Algebra and Geometry. At the same time new courses under the name of General Mathematics began to appear. Most of you will probably agree with me that neither of these changes have proven to be entirely satisfactory. The changes were expedient in restoring pleasant relations between school and home. They were not a satisfactory solution of the basic problems.

As my talk is concerned primarily with the needs of college students for mathematical training on the high school level, I will not attempt an evaluation of courses in General Mathematics. Opinions vary. Personally I do not believe that such courses have been complete failures. The fact that they are still changing is evidence that they are not yet entirely satisfactory.

In the colleges there was a quick adjustment to the lowered standards, especially in Algebra. A comparison of College Algebra texts published in the past two decades with those published about 1900 reveals startling differences. All the widely used texts today give about half their space to topics which formerly were briefly reviewed. The effect of the introduction of courses in General Mathematics was not felt immediately in the colleges. College entrance conditions continued to include the ancient admonition of Plato.

Shortly before the second war college enrollments began to rise. There was a big drop during the war but in 1946 and 1947 the rise was phenomenal. The state institutions are especially crowded. Private schools with limited endowments have had to limit their enrollments. While doing so, they have been able to make selection of better qualified students. They have not yet felt the full impact of inadequately prepared high school graduates.

The state universities and colleges are dependent on the state legislatures for appropriations and the ligislators cannot ignore the wishes of the voters. We appear to be rapidly approaching the day when the only admission requirement to a state institution of higher education will be the possession of a high school diploma. In too many cases that diploma will be issued on the basis of courses originally intended for non-college students.

Admission to a college does not mean that a freshman is prepared

to follow the pursuit of any course of study he may choose. Regardless of the action of boards of trustees and faculty committees on admission, there are courses of study that make severe demands on the mathematical preparation of the student.

Certain questions arise:

1. Which college curricula demand a knowledge of mathematics?
2. How much mathematics is required?
3. What specific courses are needed, and why?

Few American colleges offer Plane Geometry and beginning Algebra for credit. In fact few offer them at all. Our sequential courses begin with College Algebra and Trigonometry. The preparation for these includes three semesters of high school Algebra and a year of Geometry. Hence the student who follows a curriculum which contains a single course having mathematical prerequisites must begin his preparation while in high school.

At the risk of oversimplification of the question I will try to divide all college curricula into three groups.

1. Those that make relatively heavy demands on mathematical training—Calculus and beyond.
2. Those that require at least one course which demands some mathematical preparations but less than a year of college mathematics.
3. Those that have no technical mathematical requirements.

In the first group may be listed most all branches of Engineering, concentration areas in Mathematics, Physics, Meteorology, and some but not all concentration areas in Chemistry, Geology, and other sciences.

Engineers need to complete the elementary Calculus in the sophomore year. For this reason engineering schools will probably continue to require two and one-half years or more of mathematics for admission. This requirement is common knowledge and most boys—and girls—who aspire to become engineers include in their high school courses all the mathematics offered. The need for mathematics in some branches of engineering is increasing. Unless more mathematics can be taught in high school so that Calculus can be begun in the freshman year it may become necessary to extend some engineering courses beyond the present four years. Such fields as Electrical Engineering and Aeronautical Engineering are making use not only of Calculus but of Partial Differential Equations, Vector Analysis, Matrix and Tensor Calculus, and various selected topics from Advanced Calculus. At present courses with such prerequisites must be deferred to the graduate school but many of them are such that they should be part of the training on the undergraduate level.

The same need for more advanced courses in mathematics is rap-

idly developing in the field of Physics and in some branches of Chemistry. The general field of Electronics in Physics, or of Nuclear Forces which seems to belong to both Physics and Chemistry, are examples of studies that make heavy demand on mathematical analysis. May I remind you that in Europe with a different school system the student of Engineering or Science ordinarily completes courses in Calculus, Differential Equations, and Theory of Equations before he enters college. The need for much more mathematical training in the pre-college program is a present actuality, but so far the high schools have not reversed the trend toward less.

If I were inclined to be sensational, I could make a strong case here in the name of National Defense for a complete revamping and intensification of the mathematics program in the secondary school.

Turning now to the second group of curricula which require some mathematical preparation we find the number surprisingly large. Among the professions that are usually regarded as non-mathematical there are many that include in their preliminary work one or more courses that either require some college mathematics or at least the same preparation in high school mathematics as is required for College Algebra. The courses which appear most frequently are Chemistry, Physics, Statistics, and Mathematics of Finance. Pre-Medic courses include both Chemistry and Physics. Beginning Chemistry work is seriously handicapped unless the student is already familiar with equations. Use of fractional exponents is encountered, and the use of slide rule or of logarithms is valuable. A student in a first course of Physics will encounter all of these and in addition, the use of Trigonometric functions. This means merely that the future doctor of Medicine needs the same preparation in high school mathematics as the future engineer, but requires less of college mathematics. Chemistry is also found in the curriculum for the student of Nursing, Home Economics, Veterinary Medicine, Pharmacy, Forestry, Agriculture, and many more. Not many years ago most of us thought of an Entomologist as a strange individual chasing butterflies. Today we turn to the Entomologist for pest control. His problem may be Japanese beetles or the corn borer one year, diseases of peach trees another, and termites in our homes between seasons. Chemistry is an important part of his training. None of these are regarded as mathematical fields but since they require Chemistry they do require a knowledge of high school mathematics, especially Algebra.

The field of Statistics has lost none of its importance in spite of the notable failure of the Gallup Poll in the recent election. The study of advanced courses in Statistics requires a background of Calculus. The expert in this field must be a mathematician as well as a statis-

tician. There are not many in the country who qualify. More are needed than exist. The study of elementary Statistics requires only College Algebra. A knowledge of the Elements of Statistics is needed for some advanced courses in Education, Economics, Sociology, Business Administration, and other fields, including in some instances the biological sciences. How much of statistical theory and hence how much mathematical training a given individual will need depends on how far up the ladder of success the individual will go. It would be absurd to insist on Calculus and advanced theoretical Statistics courses for all teachers, social workers, and business men. Yet there are many who will need at least a knowledge of the elementary field.

The Mathematics of Finance likewise rests squarely on a foundation of Algebra. Some knowledge of it is essential to accountants, lawyers, bankers, insurance actuaries, and others. Perhaps our democracy would be much safer from the political rabble rousers if the application of the principles of annuities were part of the common knowledge of all voters. That is only a dream which probably will never become a reality. So far as the student advisor in high school is concerned one fact is outstanding. Geometry is desirable and Algebra is essential for any field of specialization that involves the elements of the Mathematics of Finance, Statistics, Chemistry, or Physics.

There is still a third group in my classification. One may well ask what courses of study are to be open to the college freshman who is accepted for admission to college on the basis of one year of General Mathematics. Perhaps you expect me to claim there are none. That is not the case. A knowledge of mathematics is not necessary for the study of language. Rather the reverse is true. A reading knowledge of from one to three or more foreign languages is highly desirable for the student of advanced mathematics. Literature, Journalism, Theology, the theatre, and radio are all examples of the broad field of language arts in which mathematics is of disputed value. I use the word disputed since some have seen fit to argue the worth of mathematics as training in accurate thinking in any field. I am inclined to agree, but prefer to confine my remarks to requirements rather than indirect benefits. Other fields open without mathematical preparation include Music and the Fine Arts, some of the Social Sciences, and, except for the need of Chemistry and Statistics, most of the Biological Sciences. The field of Elementary Teaching is wide open. It will be many years before the need for additional teachers can be met. However desirable you and I may agree that mathematical training would be for the elementary teacher, there is little likelihood of increasing the requirements until the shortage is met. There are possibilities in the schools of Commerce. The Accountant will need Mathe-

matics of Finance and the Business Administrator will find Statistics required. Clerical and stenographic fields, selling, and advertising are all examples of fields in which little mathematics beyond arithmetic are required.

We are accustomed to think of separating our students on the basis of mental ability rather than the basis of their future needs. Psychological tests and teachers' ratings serve this end in our schools. The separation of high school graduates into college students and non-college students too often is based not on mental ability of the student but rather on the financial ability of the parents. It may not at present be possible but we should bend every effort to make the separation on the basis of need, at least so far as required courses are concerned.

A few weeks ago your chairman, Mr. Cripe, wrote asking if there were any materials—blackboard, projector, etc.,—which I would need. I asked for one crystal ball in good working order. Personally, I have no faith in them, but in closing I would like for you to help me play a game of Let's Pretend.

Let us pretend that we had a crystal ball in good working order. As your students arrive at your school next Monday morning we will separate them into groups on the basis of the mathematical training they will need. After they are seated we will look again into our crystal ball and see our students not as they are today but as they will be in thirty years. Probably the larger group will be those who needed no mathematics beyond our general course. Most of them will be clerks, salesmen, and laborers, but not all. You see a distinguished looking man. He was sports editor on the school paper, later he became a reporter for the Associated Press and today is the highest salaried News Commentator on the radio networks. Another is the author of a recent best seller. Still another is the philanthropist who has just given a million dollars to endow a home for aged mathematics teachers. Looking further we see a man not too well dressed whose face is familiar. We recognize him. He is the garbage collector who comes up the alley every Tuesday and Friday. We are forced to admit that the sectioning on the basis of need has not given us the same grouping in our terminal course in General Mathematics that we made in September 1948. Referring to our class books we find that several of the outstanding successes were among those that took all the mathematics offered while they were in high school. We try to convince ourselves that they became successful because they took mathematics beyond their need. As mathematicians we reject the conclusion as not proved. As mathematics teachers we are guilty of wishful thinking, and find it difficult to reject an idea which we wish to believe.

Again we gaze into the crystal ball and see the group who did need

mathematics. We recognize several who have become famous as engineers, doctors, lawyers, and scientists. But not all are wearing white collars. Here are men from factories. A machinist who took our general mathematics course and began work at his trade on leaving high school. Later after he was married and the father of a family he found that he had reached the limit of advancement with the training he had received. At age thirty he enrolled in night school to get courses in Algebra and Geometry, and Trigonometry. He had to have the Trigonometry to qualify for a better position as a tool maker. Perhaps he tried to work up to a still better job but his obligations to his family prevented him from securing the additional training needed.

We see in our group some who have failed. Remember this is the group who needed mathematics. Some needed it and were not prepared. Failure spurred some on to greater effort but the one great chance was missed. Others failed and were broken by that failure.

Neither you nor I believe in a crystal ball. There is no easy solution to the problem of the amount of mathematics that is needed in the preparation for life. Two facts stand out sharply. One is that our present practice of recommending General Mathematics to one group and Algebra and Geometry to another is based on mental ability, class marks, social or economic standing of parents, plans to attend college, etc., but it is not an effective means of separating on the basis of future need. The other is that we have been confusing credits in mathematics for knowledge of mathematics. To avoid the large number of failures we have lowered our passing requirements in the sequential courses when, instead, the requirements should have been increased in keeping with the greater demands of the present industrial age which depends so heavily on mathematical training.

The student advisor in high school needs detailed information about the needs for mathematical training in various fields. To obtain this information the Michigan Section of the Mathematical Association of America made a study covering more than forty college curricula offered by the various colleges in Michigan. Dr. Philip S. Jones of the University of Michigan, who appeared on this program yesterday, reported on this study at the meeting of the National Council last April. A similar study is now under way in Indiana. We hope that it may be completed and distributed to all Indiana high schools in 1949. These studies will not solve all the difficulties. Similar studies need to be made for industry, commerce, the armed forces, in fact for all walks of life. Our mathematics program will not function with 100% efficiency until we can determine the proper type of terminal mathematics course that should be recommended for each student.

GEYSER—WORKING MODEL

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Clifford E. Lloyd's article, "Old Faithful" in the November, 1948 SCHOOL SCIENCE AND MATHEMATICS proves to be most interesting. His device illustrates steam pressure, atmospheric pressure, electrolysis, conversion of electric energy into heat energy, and the principle of one kind of automatic switch. But, as Lloyd himself concludes, "That it has some of the characteristics of a geyser is incidental."

It appears that a true geyser model—one which operates in the same way as its natural counterpart—would be a most useful demonstration for classes studying physics, general science, or geology. Such a device would also illustrate the force of steam and the variation of the boiling point with changes in pressure. The model suggested on these pages is neither original nor new. The writer first saw it used by Charles K. Arey, formerly of Teachers College, Columbia University, and now of the University of Alabama. It has doubtless appeared in print on previous occasions, although it can scarcely be termed a "stock item." It is submitted here for the benefit of those who have not seen it elsewhere.

The generally accepted notion of a geyser assumes a deep and narrow body of water, such as would exist in a large fissure in rock. A typical geyser might be of the order of a hundred feet deep and yet have a surface area of a few square feet or less. The heat of the earth must be sufficient to boil water well below its surface. Furthermore, the water must somehow be replenished after it has been expelled. That this rigid combination of circumstances is so seldom found accounts for the fact that geysers are a distinctly rare natural phenomenon.

The key to understanding the performance of a geyser lies in appreciating the significance of its depth. The pressure at the bottom of a 100 foot column of water is about 43.4 lb/in^2 above atmospheric pressure. Neglecting effects of altitude and dissolved impurities, the boiling point under these conditions is nearly 144°C. This, of course, is the temperature to which the *bottom* of the water column must be heated before it boils.

When the boiling point has been reached, a bubble of water vapor forms. This forces some water from the orifice at the surface of the earth. As the column of water spills over at the top, its depth decreases and its reduced weight can no longer confine the force of the super-heated steam below. The more water is expelled, the less its weight becomes; this is a condition of unstable equilibrium. The water is forced out the narrow orifice, and super-heated steam follows.

In short, the geyser erupts. It is for precisely the same reason that a liquid-filled test tube often "spits" when improperly and unevenly heated.

The geyser cycle is repeated when the cavity becomes sufficiently filled with water and sufficiently heated to duplicate the necessary conditions. The water is replaced through some combination of spring or seepage water and return drainage from the previous eruption.

The working model shown in the diagram is obviously a miniature fulfillment of the conditions outlined above. The basin-shaped "earth surface" is added in an attempt to make the model a repeating one,

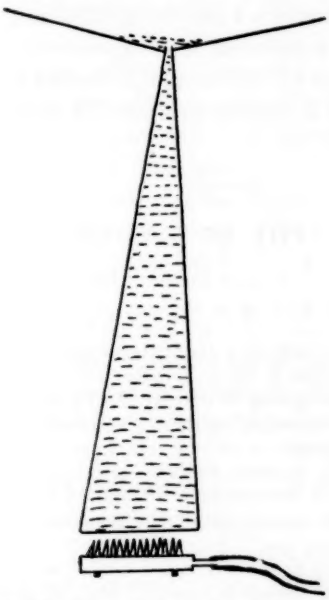

FIG. 1. A working model of a geyser, constructed of sheet metal and heated by a large burner or several small ones.

and also to protect classroom floors. The bottom is broad to permit liberal application of heat and to provide an increased water supply. Since the entire device can be produced in a school shop, its production constitutes a suitable student project.

The model seen by the writer was about four feet deep and contained perhaps a gallon of water. Much smaller models will function, though less spectacularly, and might be more practical for indoor performance. In any event, users must experiment, particularly with the size and shape of the orifice, to obtain optimum results.

This device may be presented so as to offer a problem-solving experience. Students can be asked why the water does not boil away

quietly, as in an open pan. As they suggest possible effects of pressure, temperature, etc., they can be urged to devise ways to check their hypotheses by actual experiment. For example, water temperature at various depths can be measured by thermometers in one-hole stoppers inserted through the sides of the water column.

The duration of one cycle of performance of a geyser depends on many factors, such as the rate of heating, the rate at which expelled water is replenished, the temperature of the water supply, and atmospheric pressure. It is therefore not surprising that natural geysers are somewhat fickle in their performance.

Thus the Giant Geyser in Yellowstone National Park spouts at intervals which vary from four to sixteen days. Its eruption lasts for about an hour and reaches a height of 250 feet. Old Faithful Geyser is more famous and somewhat less capricious. The interval between its eruptions averages 65 minutes, but varies from 35 to 80 minutes. Its eruption reaches a height of 100–150 feet and lasts nearly five minutes.

THE QUIZ SECTION

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1. A coil-spring in the form of a truncated cone is supported at its *smaller* end and set into vibration with a mass M attached at its lower end. How will its period be changed if the spring is inverted? (That is, the *larger* end is fixed to the support and the load is attached to the smaller end.)
2. In the first case stated in #1 the exact period involves one-third ($\frac{1}{3}$) the mass of the spring in the familiar radical expression. How does this "effective" mass of the spring enter if the spring is supported by its larger end?
3. What portion of the spring enters the expression if the spring is a uniform cylindrical one?
4. A circle A is turning around its fixed center with uniform angular velocity ω, while a circle B whose radius is one-half that of A rolls on the outside of A with uniform angular velocity ω. Find the time for the center of B to return to ts initial position. Consider all cases.

NEW PAIN-KILLING CHEMICALS

A new pain-killing drug more potent than cocaine and chemicals that give temporary relief from high blood pressure may emerge from the chemical laboratory shortly. These developments reported to the American Chemical Society need successful use upon human patients before they can be made generally available.

Best of all chemicals tested in a five-year search for local anesthetics, the new pain-killer is known as SKF 538-a and is a complex quinoline synthesized by a new method. Its pain-killing effect in animal experiments lasted much longer than cocaine, procaine, or dibucaine.

TEACHING PUPILS TO THINK IN SCIENCE—CHEMISTRY*

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One of the simplest devices to get pupils to think in science is to exhibit or to demonstrate something new—something that is fresh from research laboratories or something that is just a little beyond the scope of the textbook that is being used. Examples are metallic hydrides in chemistry, a different pulley rig in physics, or turkeys grown to fit a roasting pan in biology. After a brief discussion, the teacher can ask: "How is calcium hydride made? Compare its yield of hydrogen with that of metallic calcium, pound for pound. Compare the expense of making hydrogen using calcium hydride with that of using other means. When is an expensive but efficient method justified? What other uses has calcium hydride?"

Drawings of pulley systems can be found in dictionaries and in encyclopedias, especially old ones. Ask: "What is the mechanical advantage of this involved system? How can we check the answer experimentally?"

If live poultry is not practical in the classroom, a picture may serve. "Compare the weight of white meat per bird among birds of different kinds. Could tomatoes be grown of such a size that they will pop into a canning jar without cutting? How are modifications of this sort accomplished?"

In fact, several times per year the lesson assigned should not be labored at all in class. Instead, developments stemming from the lesson should be discussed. These would be the red-letter days on which the neglected portion of the class, the leaders, would be served. Teachers can get up-to-date materials from industries.

Some biology experiments include a description of the elements, carbon, hydrogen, oxygen and possibly a few more. Then the experiment concludes with mention of the fact that organic compounds are composed of these elements. An entirely false impression may be left with the student because the organic compounds have not the slightest resemblance in properties to those of the constituent elements. A far better experiment for biologists-to-be is an experiment exploring the nature of a chemical change and showing an example of the four principal types of chemical changes, decomposition, combination, replacement, and double replacement.

Incidentally, the preparation of oxygen from potassium chlorate is

* A portion of a demonstration lecture given October 8, 1948 before the Science division of the Vermont State Teachers' Convention at Burlington, Vermont.

an inappropriate method for a biologist to use. A more suitable experiment is the decomposition of hydrogen peroxide by the enzymes in yeast.

Ecclesiastes 12:9 states, "Because the Preacher was wise, he still taught the people knowledge; yea, he pondered, and sought out, and set in order many proverbs." Likewise, we teachers must set in order many items for rapid learning. The replacement list of the elements, for example, is learned readily by the name PCS Mazintl. By saving time in the drill of learning we are ready to use the list for thinking. The electromotive series is a list of the metallic elements in the order of their electropositive or electronegative character. The most electropositive element of those studied in high school stands first, potassium. Then comes calcium followed by sodium.

$Cs = Cs^+ + e^-$	3.02	E°
$Li = Li^+ + e^-$	3.02	
$Rb = Rb^+ + e^-$	2.99	
$K = K^+ + e^-$	2.92	
$Ba = Ba^{++} + 2e^-$	2.90	
$Sr = Sr^{++} + 2e^-$	2.89	
$Ca = Ca^{++} + 2e^-$	2.87	
$Na = Na^+ + e^-$	2.71	
etc.		

Let us take the example of the electrolysis of salt water, sodium chloride solution at a relatively low applied emf. The solution contains Na^+ ions from the salt and H^+ ions from the water. The latter are in low concentration, about one in every 1×10^7 molecules of water ionizing. When we apply a low voltage potential difference between inert electrodes immersed in salt water, which ion discharges more readily? Students will think it out correctly, namely, the H^+ ion. ($H_2 \rightarrow 2H^+ + 2e^-$ at 0.00 volts.)

Because of this fact, we should not teach that the reaction $Na^+ + e^- \rightarrow Na$ followed by $2Na + 2H_2O \rightarrow 2NaOH + H_2 \uparrow$ as the only possibility.

As far as the choice between anions Cl^- and OH^- goes, the experimental evidence is clear and Cl^- ion is more readily discharged.

Likewise in the case of the electrolysis of water containing sulfuric acid, clearly H^+ ion is discharged at the cathode. The anode reaction may involve the discharge of SO_4^{--} ion present from the acid or the OH^- ion present from the water. In this case, experimental evidence points to the reactions $4OH^- - 4e^- \rightarrow 4OH$ and $4OH \rightarrow 2H_2O + O_2 \uparrow$ as taking place more readily than $2SO_4^{--} + 2H_2O - 4e^- \rightarrow 2H_2SO_4 + O_2 \uparrow$.

How else can we account for the fact that identical products are

obtained from the electrolysis of solutions containing H_2SO_4, NaOH, or Na_2SO_4?

While we are on the topic of ions, be sure that we distinguish clearly the terms *ionization* and *dissociation*. *Ionization* means the forming of ions. Metallic salts ionized when they formed. Hence solid sodium chloride, for example, is already ionized when we get it. Evidence for this view is obtained from the X-ray diffraction pattern. *Dissociation* refers to the separating of these ions when they are given mobility either through melting or through dissolving. Our picture of the dissolving of common salt involves the breaking of the bond between the ions and surrounding the metallic ion by a cluster of water molecules. The force of addition of water molecules is not strong enough to break the bond between silver ion and chloride ion and we are familiar with silver chloride as a precipitate.

A curious type of student thinking in science may be illustrated by the discovery made by some students at a school in a remote state. They found that they could flush ignited fireworks bombs down a toilet and then scramble just in time to avoid being hit by the flying pieces of sanitary pottery as the fixture in a condition of complete demolition was leaving the building.

Further, in connection with ionization, sometime ask the pupils to list all the molecular and ionic species found in a solution of ammonia in water (NH_3, H_2O, NH_4^+, OH^-) sulfurous acid (include HSO_3^-), aluminum sulfate solution, or phosphoric acid.

We can also use the replacement series of the metals in connection with the common experiment, the decomposition of mercury oxide by heating. Will any other oxide behave similarly? Check the deductive answer by experimenting with MgO, CaO, and other metallic oxides.

We can help clear up pupil thinking on the topic of valence by pointing out that the term has different meanings according to the type of valence concerned. Some crystalline compounds are marked by characteristic high melting points and good conductivity of electricity when dissolved or when fused. These compounds are metallic salts. They are ionic in structure and the valence bond or bonds between the metallic and non-metallic parts are electrovalent. These bonds are established by actual transfer of one or more electrons from the metal to the non-metal. Sodium hydroxide fulfills this definition!

On the other hand, many compounds have low melting points and do not conduct electricity in the liquid state or when dissolved in water unless the compound reacts with the solvent. Examples are HCl, NH_3, H_2O, CO_2, CH_3OH, CH_4, etc.

In such compounds as these, the bond is covalent in character and is established by shared electron pairs. Their units are molecular rather

than ionic. These are the two chief meanings of the term valence. There are several other cases, some intermediate in character.

At the same time we should be careful to use the term *molecule* only for those compounds that have molecules as units. We have *no* molecules of strong acids or of salts in dilute solutions. Complete dissociation takes place. Apparent incomplete dissociation is explained by interference by the oppositely charged ions that form the environment of a given ion. Weak acids such as acetic, on the other hand, apparently do not ionize completely in water and molecules of acetic acid are present as well as hydrated H^+ ions, $C_2H_3O_2^-$ acetate ions, and a very few OH^- (hydroxyl) ions.

We can use the term molecule safely for compounds or elements that exist in the gaseous state.

Another type of thinking in science is brought forth by an experiment that is set up with but few directions. The student is challenged to proceed from one step to the other in its solution under his own initiative. Take an example from physics. A cord is hung loosely between two nails spaced about two feet apart in a line roughly parallel to the floor. Two weights, one known and the other unknown, are attached separately at random to the cord. The problem is to find all the forces involved in the system including the tension on the cord. The better students will resolve the pull of the cord on the nail into two forces in addition to finding the obvious unknowns.

We use the effects of hydrolysis a little in general science and a lot in chemistry; somewhat in biology and in physics. How often does the student get a chance to explain hydrolysis in terms of ions? The ionic explanation, incidentally, is exceedingly simple. Take a solution of sodium carbonate (washing soda) for example. A litmus test reveals that such a solution is strongly alkaline. A solution of sodium phosphate is even more strongly so. The presence of hydroxyl ions is evident.

The following hydrolysis reactions have gone on.

$$CO_3^{--} + H_2O \rightarrow OH^- + HCO_3^-$$
$$PO_4^{---} + H_2O \rightarrow OH^- + HPO_4^{--}$$

Also to a slight extent the reaction

$$HPO_4^{--} + H_2O \rightarrow OH^- + H_2PO_4^-$$

has taken place.

Likewise, a solution of copper sulfate or of aluminum chloride is acid because of the presence of hydrogen (H^+) (or hydronium, H_3O^+) ions developed by the reactions

$$Cu^{++} + H_2O \rightarrow CuOH^+ + H^+.$$

(We can simplify the explanation by not including the hydration of

the copper ion $Cu(H_2O)_4^{++}$.)

$$Al^{+++} + H_2O \rightarrow AlOH^{++} + H^+$$

and slightly

$$AlOH^{++} + H_2O \rightarrow Al(OH)_2^+ + H^+.$$

The complex metallic-hydroxy ions are soluble.

To show an example of dynamic equilibrium, we may use molecules or ions. The Haber synthesis, $N_2 + 3H_2 \rightleftarrows 2NH_3 + \text{heat}$ is often used. Incidentally, this concept of a dynamic rather than a static equilibrium is one of the most helpful ideas in understanding the complexities of social and economic adjustments that a student can take from his science courses. We can use as an example the physical equilibrium of a saturated solution in contact with its dissolved salt at a given temperature or the chemical equilibrium between two opposing reactions.

After equilibrium, the next step in thinking is the effect of changing conditions upon the concentration of the substances in equilibrium. Here we apply Le Chatelier's principle. Once the principle is firmly grounded, then the pupil is prepared to answer intelligently questions such as

"What is the effect of raising the temperature upon the equilibrium $N_2 + 3H_2 \rightleftarrows 2NH_3 + \text{heat}$?" "Cooling favors the formation of nitrogen tetroxide. What is the sign (algebraic) in the right-hand side of the equation $2NO_2 \rightleftarrows N_2O_4$ heat?"

A few examples of the type of thinking that we all use to challenge our pupils in physics may be illustrated. A metal water pipe is joined to another pipe of smaller diameter. Both pipes have side-arm tubes soldered to them. The apparatus is connected to a water supply so that water runs through both pipes. From which of the side-arms does the water spurt further, that from the larger pipe or from the smaller pipe?

When we study heat transfer in general science we usually arrive at the names of the three methods with a few examples of each. In physics we have the same process again plus a better explanation and more difficult examples. Cannot the class arrive deductively at the formula for heat transfer by conduction through a solid? The formula, although long, is relatively simple and it offers a good chance for the pupils to think out what factors determine the total quantity of heat transferred. $Q = kA(T_1 - T_2)t/d$

Again in physics, we always describe the boundary within which Hooke's law applies. The establishment of boundaries within which Boyle's law or Ohm's law describe nature is an interesting challenge. We may anticipate the van der Waal's corrections of Boyle's law and the fact that Ohm's law doesn't tell the entire story for high-frequency

oscillations, for conductance in gases or in high vacua, for circuits containing inductance and capacitance to which an alternating electromotive force is applied.

In all science we can make pupils think just a bit more by checking carefully on their writing. For example, a pupil writes, "I put a glowing splinter into a bottle of oxygen and it glowed brighter." Such a statement is unacceptable because (1) it contains an incomplete comparison and (2) the antecedent of *it* is not definite.

In conclusion, methods of getting pupils to think have many variations. They vary with the subject matter, the teacher, and the pupil. The art of teaching brings a harmonic symbiosis between all the factors. One teacher's meat is another's poison, however, and some types of approach are entirely out of character for a certain teacher.

Teacher A excels at the Socratic method. By skillful question and answers she leads the pupil into an enlarged outlook, at the same time strengthening the foundations.

Teacher B never heard of Socrates. He badgers his pupils by outrageous statements until they rise in defense of the textbook. They are challenged to apply what they have learned from the book in order to contradict the teacher.

Teacher C, on the other hand, having few characteristics in common with the other two, is successful by a ruse. He claims that the apparatus that was purchased to demonstrate a certain principle is somewhat out of adjustment. He asks for volunteers from the class to help make the equipment operate properly. Volunteers come, they study the principle to be demonstrated, and puzzle out how the apparatus operates. Incidentally, they learn a lot of practical science by these jobs with apparatus.

Teacher D, does his best work when demonstrating with actual materials, using them as springboards for searching questions to pupils. His storeroom is crowded with minerals from far and near, industrial materials, compounds prepared by students, crystals, apparatus that is home-constructed, and so forth.

Still other teachers are content with the "talkie-chalkie" method of teaching science. This method of helping pupils think is probably the least attractive when used alone.

PLASTIC SPOONS HELP ARMY FIGHT DISEASE

Plastic spoons are the Army's newest weapon against disease.

A new C ration (Ration, individual, Combat, C–4), announced today by the Department of the Army here, will have plastic spoons. The spoons are sterilized. sealed in cellophane wrappers and are to be thrown away after one meal. This is designed to combat dysentery, which sometimes has resulted form the use of utensils by troops with no facilities for cleaning them.

DICTOFORMS

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North Central High School, Spokane, Wash.

See the January 1949 issue of "SCHOOL SCIENCE AND MATHEMATICS" for a detailed explanation of this new type of recreation problem. Briefly, a "dictoform" is solved like a cross-word puzzle except that each word can have its letters arranged in any desired order. Only one arrangement, however, will tie in with the rest of the "dictoform." Which way is correct will not be always readily apparent nor easy to determine.

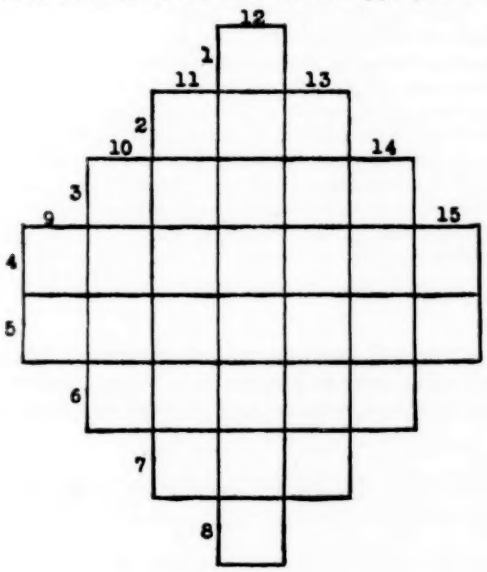
Solution No. 1

	6	7	8	9	10
1	H	E	R	E	T
2	E	V	R	P	O
3	G	E	A	N	L
4	I	N	D	A	H
5	T	S	A	L	E

The correct words were as follows: 1. THREE 2. PROVE 3. ANGLE 4. DINAH 5. LEAST 6. EIGHT 7. SEVEN 8. RADAR 9. PLANE 10. HOTEL

DICTOFORM NO. 2

(The completed solution will reveal a reference appropriate for February)



Horizontal Words

1. Chemical symbol for the element whose atomic number is 18.
2. Name of the Greek letter corresponding to r.
3. Yellowish alloy of copper and zinc, commonly used for faucets, valves, etc.
4. Calendar showing days, weeks, and months.
5. Variety of coal between peat and bituminous coal, often showing woody texture.
6. Plural of the noun, clip.
7. The numerical value of x in the equation, $2x-3=4x-5$.
8. The Roman numeral for 100.

Vertical Words

9. Abbreviation often used for Los Angeles.
10. Fluid secreted by the liver.
11. Injury to the ligaments of a joint caused by violent stretching or twisting.
12. Trigonometric function which is the reciprocal of the sine.
13. Plural of the noun, choir.
14. General name for a seaweed.
15. Chemical symbol for manganese.

REPORT OF THE CAS&MT

Physics Section

The annual meeting of the Physics Section of the Central Association of Science and Mathematics Teachers was called to order on Friday, November 26 by the Chairman, Mr. Frank H. Ulveling, Schurz High School, Chicago, Illinois. Mr. Ulveling introduced the Vice-Chairman and the Secretary of the section. He then appointed a nominating committee consisting of Dr. G. P. Cahoon of The Ohio State University, Mr. Kenneth Vordenborg of Withrow High School, Cincinnati, Ohio, and Mr. Eiffel G. Plasterer of the Huntington High School, Huntington, Indiana. The first speaker was Mr. H. Clyde Krenerick of the North Division High School, Milwaukee, who gave an illustrated lecture on the use of certain types of home made equipment in the high school physics laboratory.

The second speaker was Dr. Philip G. Johnson, of the United States Office of Education, who spoke on the topic of "Planning Your High School Physics Courses." Through this address Dr. Johnson gave stimulus and guidance in ways of making physics functional in the high school situation. The third speaker was Mr. Robert D. Beckman, of the Allison Division of the General Motors Corporation, who gave an illustrated lecture on jet propulsion, the title being "Breaking Through the Barrier." The address was interesting, informative, and timely. The manuscripts of the addresses that Dr. Johnson and Mr. Beckman gave will be made available for publication in this Journal. The Chairman of the Nominating Committee presented the names of the following persons who are unanimously elected: Chairman, J. Leo Walton; Vice-Chairman, J. S. Richardson; Secretary, Delia Redman.

J. S. Richardson

Robert Andrews Millikan was born March 22, 1868 at Morrison, Illinois. He will always have a great name in physics for his measurement of the value of *e*, for his famous tool shop in a vacuum, and his work on cosmic rays.

The first United States Congress met at Federal Hall in New York City, March 4, 1789.

AN EXPERIMENT IN FUSING PLANE AND SOLID GEOMETRY*

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Two years ago I discussed with the Junior High School group of the Association the general mathematics program which has been in operation for several years in University High School. It will be necessary to repeat a few of the statements made at that time in order to provide a setting for subsequent remarks.

First of all, the school embraces grades 7 to 12 with enrollment limited to 50 per grade. Unlike many schools of this type, a definite effort is made to keep the population as nearly normal as possible so far as ability is concerned.

Secondly, mathematics is required through grade 9 and elective thereafter. Since the school is small, and the number of teachers and classrooms limited, only a single track of instruction is provided. Courses in grades 7, 8, and 9 are general in nature with the hopeful goal of providing what the Commission on Post-War Plans has termed "Functional Competence."

Thirdly, since functional competence embraces roughly one semester of algebra and a large part of the domain of informal geometry, grade 10 is devoted to a study of second- and third-semester algebra, and grade 11 to plane and solid geometry.

The geometry course is now in its fifth year and, although objective results are too few to be of any consequence, the evidence we have accumulated of pupil interest and achievement is very gratifying. Perhaps a brief description of the course will be of interest to teachers in other schools.

The fusion of plane and solid geometry is by no means a new idea. Descriptions of, and recommendations for, such courses have appeared in the literature off and on for many years. The Fifth Yearbook of the National Council of Teachers of Mathematics, written in 1930, carried two such articles. In an editorial in the May, 1944 issue of the Mathematics Teacher, Professor Reeve made the following statements:[1]

> Senior high school mathematics must also be reorganized. It should be a continuation of the general mathematics program of the junior high school with demonstrative geometry (plane and solid) furnishing the core for the tenth grade. . . .

Still later, Professor Harl R. Douglass, in an address to this section of

* An address to the Mathematics Section of the Central Association of Science and Mathematics Teachers, Indianapolis, November 26, 1948.

[1] "Mathematics in the Post-War World," *The Mathematics Teacher*, April 1944, 235–236.

the Association, made the following remarks[2] concerning the courses which should be offered in "track two," the college preparatory track:

> This well-worn track is in need of straightening on the curves, new ballast, and streamlining. In most schools it probably should begin in the tenth grade with a thorough one-year course in formal algebra. In the eleventh grade, plane and solid geometry would constitute the work of the year. . . .

In the same address he said,[3]

> The teaching of plane and solid geometry in one year need not be apologized for. In the smaller schools students wishing to take solid geometry are not numerous enough to warrant giving it. In any school devoting one and one-half years of instruction in geometry there is a disproportionate emphasis on geometry as compared to algebra in view of its practical advantages, even may I say for those who will be engineers or scientists.

A similar argument which is frequently given for the course is that even in large schools relatively few pupils study solid geometry as such whereas a large number are usually enrolled for plane. The important concepts of three dimensions, which may assume even more importance in an air age, are consequently missed by all but a small fraction of the population. During the war, with a naval pre-flight school and various army programs on our campus, this argument weighed heavily in our decision to adopt the course on at least an experimental basis. Immediate and continued success has encouraged its retention as a standard part of the program.

The lists of theorems (both plane and solid) which were labeled "fundamental" by the National Committee on Mathematical Requirements[4] were organized into a one year project and, with a few minor changes, became the basis for the course. At the end of the first year several pupils disclosed plans to enter technical schools upon graduation and requested a full one and one-half year of instruction. To meet this demand, a third semester was established and is still being taught. Thus grade 11 is devoted to a study of those concepts and relations which are considered to be most important, and the first half of the twelfth year provides a review and extension of this material. The net result is a fusion of the entire body of knowledge ordinarily included in plane and solid geometry.

Due, in part, to the fact that no suitable textbook is available as a basic reference, classroom procedure has followed a simplified, and probably weakened, version of the "Fawcett method."[5] With the background established in the junior high school, a substantial num-

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[2] Harl R. Douglas, "Mathematics for All and the Double Track Plan," *School Science and Mathematics*, May 1945, p. 431.

[3] *Ibid.*, p. 432.

[4] "Reorganization of Mathematics in Secondary Education," report of the National Committee on Mathematical Requirements, *Houghton Mifflin Co.*, 1923.

[5] See Harold P. Fawcett, "The Nature of Proof," Thirteenth Yearbook of the National Council of Teachers Mathematics, *Bureau of Publications, Teachers College, Columbia University*, 1938.

ber of relations are already somewhat familiar to the pupils and, although the laboratory approach is utilized extensively, many of the facts are simply *recalled* rather than *discovered*. In such cases, the major purpose becomes one of stating relationships accurately and organizing them into a logical sequence.

The content is ordered very much as it is in standard texts, with parallel and perpendicular lines and planes appearing early in the course and circles and spheres toward the end. Considerable care is exercised at the outset in familiarizing pupils with elementary concepts and with the essentials of perspective drawing. Once the course gets underway, the work carries from two to three dimensions and vice versa quite naturally. Relations discovered in one space frequently have their counterparts in the other, with or without restrictions. Pupils quickly learn that such propositions as "Two lines which are perpendicular to the same line are parallel to each other" hold only in a plane and the knowledge forces upon them a super-carefulness of statement. Moreover, it tends to discourage those who would lift a few theorems from Dad's old textbook in order to impress their fellow pupils.

A typical classroom activity is to have pupils work together in small groups in the development of a unit, using whatever materials (sketches, models, or perhaps tinkertoys) are available. Each group then presents its research to the class and few Ph.D. candidates are subjected to a more rigorous grilling than these rivalries occasion. Once a proof has been accepted and is deemed important by teacher and pupils, it is incorporated into the class textbook.

Sometimes a unit produces an enormous amount of pertinent information. Two years ago an examination of polyhedral angles brought forth thirty-five relationships, eighteen of which were retained as theorems. That many of these are unimportant in the development of the course is witnessed by the fact that very few books list more than a half dozen. In the eyes of the class, however, it was a magnificent accomplishment.

The problem of measuring achievement and of comparing the results with established norms is somewhat perplexing. Standardized tests are available for pupils completing plane geometry or solid geometry, but not for those who have studied parts of each; moreover, the norms on these tests were established by examining pupils of different grade levels and mathematical maturity; in all probability, the average plane geometry class is less capable than ours and the average solid geometry class more capable. In spite of these discrepancies, the only possible solution is to administer those examinations which exist.

Our original concern was with the damage done to the pupils by

eliminating part of the plane geometry course. Consequently, Forms A and B of the Schorling-Sanford Achievement Test in Plane Geometry were the only ones given the first year. Since that time, however, various forms of the Cooperative Test Service Tests in both plane and solid geometry have been used. Standard practice has been to administer these tests at the beginning of the course, at the end of one year, and again at the end of the third semester. The results to date are given in the following tables:

Plane Geometry

	Pre-Test				1 Year				1½ Years			
Class	Q_1	Q_2	Q_3	M	Q_1	Q_2	Q_3	M	Q_1	Q_2	Q_3	M
1946	0	0	1.5	2.9	38.5	62.5	87	62.9	90.8	96	97.5	92.8
1947	2	29.5	50	26.4	56.0	86.0	96.4	80.0	84.5	93.3	98.8	91.9
1948	7.5	24.2	59	29.6	61	88	97.6	80.1	96	97.3	99	95.5
1949	4	19	32	25.0	71	93.8	97.8	81.4				
Total	0	12	37	21.5	58	83	96	73.9	90	96.5	98.5	93.4

Solid Geometry

	Pre-Test				1 Year				1½ Years			
Class	Q_1	Q_2	Q_3	M	Q_1	Q_2	Q_3	M	Q_1	Q_2	Q_3	M
1946									47.3	78	96	68.3
1947	10	12.5	18	13.4	16.5	22.8	45	34.6	31.5	58	85	57.8
1948	7	10	12.5	10.2	19.5	36	74.5	44.5	68.8	81.8	94.3	77.6
1949	0	8.5	14.5	8.0	21.3	66.3	95	57.6				
Total	4	10	13	10.0	21	36	74.5	47.1	49.5	76.3	93.5	68.5

All scores are in terms of percentiles. For each test and each year of instruction the quartiles (Q) and arithmetic mean (M) are listed. The columns headed "class" refer to the year in which the pupils received, or will receive, their diplomas.

Three characteristics of the tables, each of which may cause the results to be misleading, should be mentioned:

1. Scores made on the Schorling-Sanford Examinations are quite different from those secured on the other tests. This is certainly due, in part, to the fact that pupils in an experimental school are "test-wise" when the items are of the true-false or multiple-choice variety.
2. Totals given for the first two parts of Plane Geometry involve scores made on two quite different tests.
3. Scores made at the end of one year on the solid geometry tests are probably lower than actual achievement. Due to the methodology employed, the pupils seldom had time for an adequate

study of spheres, a topic which is heavily weighted in the examinations.

In general, it is probably true that the plane geometry scores are spuriously high and the solid geometry scores spuriously low, particularly for the one-year groups.

As was mentioned earlier in this paper, the results are too meagre to be of any particular consequence since only 79 pupils are involved in the entire four year period. However, there are some ***indications***, two of which may be of considerable importance. The first of these is that a complete fusion of plane and solid geometry may produce better results than is now obtained through separate courses.[6] The second, and by far the more interesting and far-reaching, is that, given proper content, organization, and methodology, one year of instruction may provide sufficient training for all but the most exacting curricula. The outlook is particularly promising for the thousands of schools in the country in which only one year of instruction in geometry can be provided.

Whether a course of this type would operate effectively at the tenth grade level, and with only first year algebra as the background, is a moot question. One may very well ask, of course, whether it would be successful on a large scale under *any* conditions. As some of you may know, the State of Iowa is now completing a revision of its secondary school curriculum in mathematics. Embodied in the program is a one-year course in plane and solid geometry, placed at the junior level, and preceded in the junior high school by a series of general courses whose goal is functional competence. If a sufficient number of schools adopt the program, we may have some sort of answer to the question in a few years.

[6] This should be expected since geometry would then assume the "review and extend" quality which characterizes our algebra courses. Such overlearning is an important factor in promoting retention.

EIGHT DAYS OF FUN AND MATHEMATICS

An Institute for Teachers of Mathematics in New England

To be held on the Wellesley College Campus, Wellesley, Mass., August 23 through 30, 1949.

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PLANNING YOUR HIGH SCHOOL PHYSICS COURSES*

PHILIP G. JOHNSON
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A number of years ago an outstanding American physicist gave emphasis to the thesis "physics is physics." He indicated that the content and organization of physics was no accident. He stressed the careful growth of physics as physics and discouraged tampering with a course which had resulted from the best thinking of those who knew the field of physics. At about this same time it was my responsibility to work with high school science teachers, and in visiting a physics class a student brought me the textbook and pointed out the subject under discussion. The discussion was progressing from point to point in the book. I soon began to turn the pages to see what had been discussed previously. Near the beginning of the book I noted the treatment of properties of matter—general and special. Along the margin of one page some student had written, "Matter, matter, what does it matter?"

There are many high school physics courses today that indicate the "physics is physics" idea. There are also many high school pupils, many of whom have not and will not study physics, who indicate by their election of other courses that "physics does not matter." There are pupils in physics courses who demonstrate by their degree of interest the same general attitude. It should also be said that there are schools, teachers, and pupils who demonstrate that physics matters very much.

It would be possible to assume one of two premises in developing the subject before us. One premise would be that you are physics teachers and that you are going to continue as physics teachers. Another premise would be that while you are physics teachers now you should not or you cannot continue to be physics teachers. Since I wish my comments to be immediately helpful, I wish to develop the subject along the direction of the first premise and then consider briefly what types of thinking the second premise would require us to do. Let us consider then a few ways by which our high school physics courses might be improved by further planning.

I. The high school physics course could be arranged in terms of problem questions rather than in terms of topics and sub-topics.

Let me hasten to indicate that by problem questions I am not thinking of numerical problems. I am thinking of perplexing situa-

* An address to the Physics section of the Central Association of Science and Mathematics Teachers, Indianapolis, November 26, 1948.

tions, practical difficulties, and confusing alternatives which require as their basis for understanding and explanations certain fundamental principles of physics. Thus instead of beginning the physics course with a consideration of "Properties of Matter" or "Matter and Forces," it would be possible to begin with the question: What standards must the balls meet which are used in athletic events? Instead of announcing the topic "Mechanics of Fluids," it would be possible to introduce the problem: How does a pilot control an airplane? Instead of studying the "Properties of Light," a physics teacher could launch this topic with the question: How does a camera operate? Instead of assigning for study the topic of "X-rays and other Radiations," the physics teacher could introduce the problem: How is atomic energy produced and used? For each and every topic in the physics course it would be possible to plan challenging questions which when pursued by the pupils would provide opportunities to learn all the essential facts and fundamental principles of the high school physics course.

It would be possible for me to make a strong plea for pupil-teacher planning of problem areas but I am going to emphasize a more conservative approach—namely, try to plan intriguing questions to be used for launching what has formerly been announced as a rather impersonal topic. One of our recent physics textbooks has leaned in the direction of this suggestion by assigning the following wording to the topic usually known as Properties of Matter: "How do molecular forces explain the properties and behavior of matter?" I do not believe that the usual high school junior or senior will be enthusiastic about the prospect of finding answers to this problem question. However, in September with the World Series coming up and the football squad beginning to work out, I can believe that many students, both boys and girls, will be somewhat eager to find out about the properties of baseballs, footballs, basketballs, and other sports equipment. From some such problem question as the one given above, the physics teacher can help pupils to the correct use of terms as these relate to matter, the understanding of weights and measures, and a feeling that physics does matter in many, many ways.

II. The high school physics teacher could encourage and guide pupils to use scientific methods in solving their problem questions.

This would mean that the primary responsibility of the teacher of physics would be to help pupils learn as contrasted with teaching physics to pupils. One step in this process would be to help pupils gather facts pertinent to the problem under study. In planning for such teaching, the physics teacher would find it necessary to plan answers to questions such as the following:

a. What questions can I ask that will help pupils to recall the pertinent experiences and facts which they have previously acquired?
b. What demonstrations can be performed in order to provide settings for pupils to observe and to record additional pertinent facts?
c. What experiments can pupils perform individually and in small groups, and how can I help them to note accurately what was done and what happened?
d. What visual aids such as films and slides can I project which will provide further bases for observation and acquisition of pertinent facts?
e. What textbook, pamphlet, and reference reading can I ask pupils to do in order to help them collect further evidence bearing on the problem?
f. What additional discussions, blackboard sketches, and other help should I personally provide in order to round out and bring up-to-date their array of pertinent facts?
g. How can I help my pupils to examine and relate their facts so as to guide them to sense and express the fundamental principles involved?
h. What questions and other problematic situations can I suggest to give my pupils many and varied opportunities to use their fundamental principles and facts, and in the process to correct and fix them?
i. What projects can I encourage the pupils to undertake so that they may express in socially acceptable ways the useful things that they have learned?
j. What special enterprises can I stimulate certain pupils to undertake in order that they may further probe for facts, relationships, and applications related to the problem but going beyond what other pupils are expected to do?
k. How can I help all pupils to thoroughly fix the truly important ideas and use them today and in the years to come?

It is in pursuing this type of planning that cooperative work involving several teachers will bring rich rewards. There must be simple questions, rather obvious experiments, and easy reading as well as moderate and involved suggestions, because the physics teacher can find good use for ideas that will prove effective in helping those who learn slowly and by easy stages as well as for those who grasp situations quickly and who would be bored unless there are difficult and perplexing situations which must be faced and resolved. What is needed is a very rich collection of suggestions from which the busy teacher can select activities suitable for the pupils, facilities, and equipment at hand. I do not know of any such rich source of suggestions except in the working plans of actively employed high school physics teachers. Your North Central Association has made available the results of cooperative planning by other groups of teachers. May I suggest that you as a group of physics teachers make plans for collecting, arranging, and making widely available instructional suggestions for physics teachers.

III. The high school physics teacher could encourage and guide pupils to work cooperatively in study groups following general plans which have been developed in advance.

As an example, suppose the pupils have been brought to see the general extent to which various types of machines are used in the

home, school, and community. It would be possible to have a small group of students explore and study how gears are arranged and used. Another group could specialize on levers, another on inclines, another on hydraulic devices, and thus the gamut of simple machines would be investigated. The groups could be established by one of several common methods and they could work by their own planning and your casual guidance for a week or two. Following such study you would have the truly significant opportunity to guide the reports from pupils and groups in such ways as to focus attention on the fundamental general principles and the generally useful facts. Through such group work you would be making a major contribution to the growth in skillful use of democratic processes while providing freedom for recognition of differences in interests and abilities. There is scarcely a topic or general problem area in physics where group planning and working could not be arranged by careful planning. Here again cooperative work by several physics teachers would help to develop suggestions which would greatly enrich the teaching of physics.

IV. The high school physics teacher could so arrange his suggestions for guiding the learning of his pupils that most of the pupils could follow the plans for several weeks with but little direct help by the teacher, thus leaving the teacher free to encourage the able students to work up to their abilities as well as to help the students who need extra assistance.

There are several types of long-time assignments which are used extensively by many teachers but which are seldom used by physics teachers. What I have in mind are differentiated assignments of the contract, mastery, and project types. They require much advance planning because the teacher must answer these questions: Which suggestions if followed would meet the minimum requirements for satisfactory performance in my class? Which suggestions if followed would meet the average or good performance level in my class? Which suggestions if followed would meet the superior or excellent performance level in my class? The teacher would then express these suggestions so that they could be readily understood by the pupils and arrange them together with the materials and facilities required so that each student could select with the teacher's help the appropriate performance level and then be free to work out the suggestions as arranged. Plans for evaluation of progress need to be completed so that they will be ready for use. A plan for introducing each major plan of individualized instruction should be thought out so that the pupils will understand both why this plan has been introduced and how they may cooperate most effectively in realizing the benefits which the plan can make possible.

Many physics, and other teachers for that matter, object to group and individualized instruction because they do not see how the subject matter can be covered by such plans. They say that they have so little time for their subject anyway that direct teaching seems to be the only way to cover the work. I know what they mean, but through experience with these plans of teaching I am convinced that the interest and zest which is generated by these modified procedures will go a long way toward making up for the apparent slowness of the progress. Then too both the pupils and the teacher will learn much more than physics in following such plans. I assure you that it requires much planning and replanning to conduct individualized instruction. The first time or two you use the plans you will feel like an inexperienced golfer or bridge player. It is through actual experience that your skill will grow. Since many of the difficulties of physics teachers stem from differences in the abilities and interests of pupils, I suggest that it may be very worthwhile for you to plan and undertake an individualized or group plan for one or two of your usual blocks of physics subject matter. Then by sharing your plans and experiences with others you will help to improve physics teaching in our high schools.

V. The high school physics teacher could plan cooperatively with other teachers in the school for bringing certain scientific developments to the attention of all teachers and pupils, and through them to the people of the community.

Let us consider as an example the area of atomic energy. Here is an area where there is great need for fundamental physics to reach every person in the school and community. It is not enough that you help your physics pupils acquire facts, principles, and understandings related to this area. A certain part of such facts, principles, and understandings should reach every person in the school and community. Thinking related to social implications along with the basic scientific understandings is seriously needed.

The physics teacher should actively participate in such planning and should feel a responsibility for initiating such planning where little or nothing has been done as an all-school project. It is appropriate to mention a word of caution to you as physics teachers; namely, reduce your contributions to very simple terms. Perhaps you could develop the idea that man has learned how to release energy in a manner similar to the way in which the sun and stars have been releasing energy for countless ages. You could elaborate somewhat about the similarities and differences in the processes and discuss how self-sustaining as well as explosive reactors are arranged and operated. You can help pupils prepare demonstrations using mouse traps, pin

balls, matches, and other materials to demonstrate some of the basic ideas. You can help to clarify the idea that there are no basic atomic secrets, but that there are many facts about design and operation which have been learned by prolonged study and experimentation and that much of this know-how is restricted to the point of secrecy. However, you can point out that other people with time, extensive study, and facilities for experimentation may discover similar and perhaps more significant know-how. You can point out the scientific essentials of an effective plan of control, and you can help to make this understood by all persons. You can make yourself familiar with the many and far-reaching potential benefits from peaceful use of atomic energy, and you can help others to understand what such developments may mean in terms of vocations, health, and enriched living. You can also work cooperatively with school and community leaders so that all persons may be reasonably well informed about both the science and the social implications of atomic energy. Over and above these contributions you have a responsibility and opportunity to continue from year to year to study, plan, and work for broad and up-to-date knowledge and understanding of the rapidly moving atomic energy developments, the problems resulting from such developments, and what each citizen can do to encourage wisdom of action on the part of all peoples.

Similarly, although not equal to the area of atomic energy, we find such other areas as developments in electronics, jet propulsion and other aspects of aviation, rocketry, and the like. The advancing front of scientific developments needs you and other teachers to interpret them to each other and to pupils and parents in the community. Nothing less than wide and thoughtful cooperative planning can meet the crucial needs of our time.

VI. The high school physics teacher could engage in the wide planning and thoughtful experimentation necessary for the discovery of how important physical facts and principles may be made available and acceptable to all youth.

This brings us to a consideration of the planning high school physics teachers should engage in if we follow the second premise; namely, that physics as we know it should not or cannot continue to occupy your major time and attention. We can find reasons for thinking along the direction suggested by this premise if we study some of the facts about the progress of physics teaching in our schools.

There are many evidences to indicate that physics is not what it used to be. Some of this evidence is very sobering to science teachers in general and especially to those who feel that physics has many important contributions to make to the education of youth. Some of

the evidence is very heartening because it indicates that the time is ripe to do something about it, and by doing something wisely now it may be possible to prevent certain trends which may lead to serious mistakes. Let us look at the situation from various points of view.

A. While high school enrollment has been growing, physics enrollment too has been growing but at a decreasing rate.

The table below indicates the enrollment in physics and the percentage this represents of the high school enrollment. From 1910 the reports were based on those schools that responded to requests for data on offerings and registrations as requested by the Office of Education. Prior to 1910 the reports were based on all the schools.

Year	*Physics Enrollment*	*Percentage of Total Enrollment*
1895	79,720	22.77%
1900	98,846	19.04
1905	106,430	15.66
1910	107,988	14.61
1915	165,854	14.23
1922	192,380	8.93
1928	198,402	6.85
1934	281,928	6.27

You may well ask about what has happened since 1934. There has been no comparable study since that time, and we will have to wait a year or two for a report. However, there is rather general agreement that the following changes have taken place. The general downward trend continued for several years after 1934, but in the early years of World War II the trend was arrested and a rise in percentage occurred. This more favored position continued for a few years, but during the last two or three years there has again been a downward trend.

A special inquiry into the teaching of science grades 7–12 was launched in the spring of 1948, using as a basis 755 schools representing a random sampling of the high schools of the nation. A preliminary tabulation of the physics aspects of the returns has been made in order to present evidence more nearly up-to-date. Based upon 66% of these 755 schools representing the schools of the nation, the following information can be given. You should understand that this is a preliminary summary which may be changed by the returns yet to be included and by more accurate methods for preparing a summary.[1]

1. One group of schools was not used in this preliminary report because they were junior high schools, another group composed mostly of small high schools had failed to report even after four follow-ups, and a third group had failed to

provide certain data deemed pertinent to a summary for physics. The 511 school reports revealed that 252 (49.3%) were teaching physics.

2. The total pupils enrolled in the last four years of the schools was 131,158 composed of 61,073 (46.6%) boys and 70,085 (53.4%) girls.

3. The total enrollment in physics was 7,647 (5.8% of the total school enrollment). The physics classes included 5,497 (72%) boys and 2,150 (28%) girls.

4. The 7,647 physics pupils were in 378 class sections, giving an average class enrollment of 20 pupils.

5. The minutes per week devoted to physics in these schools varied from 175 to 585 with 275 as the lower quartile, 300 as the median, and 315 as the upper quartile.

6. The class time per week was distributed so that 203 (80%) of the schools reported only single periods. About one-half of these schools had five periods per week, while the others had more than five. Forty-nine schools (20%) reported one or more double periods, and about two-thirds of these had two double periods or more.

These data give only a partial picture of the place of physics in the education of youth. When one studies the full reports one cannot help but note that while physics percentage enrollment was decreasing, the percentage enrollment in general science was increasing very noticeably. In one report of the establishment of a general science course, the statement was made that a course "mildly physics and chemistry" was offered, and "little by little the other sciences found their place, until the course became in fact, as well as in name, a course in general science." Those of you who have taught both general science and physics realize that substantial blocks of physics content have been made a part of one or more of the general science courses. Many physics teachers regarded this as both good general education and also a means of interesting the proper students for further study of physics. Whatever the results, it is true that physics content has not only become a part of general science, it has also become a part of science studies at the elementary school levels.

A further look at these tables of offerings and registrations may be helpful to physics and chemistry teachers. While botany and zoology decreased in enrollment, biology was taking their place in the high school program. Now it is rare indeed that a high school offers either botany or zoology. Is a similar situation developing for physics and chemistry? What place do we desire physics to occupy in the schools of the future? What should we as physics teachers be doing now?

B. While the enrollment in physics has been growing, the enrollment in various physical science courses at the same grade levels has also been growing.

During the eight or ten years prior to the late war there were a number of plans for modified physics and chemistry courses. These were developed as substitutes for the standard courses, especially for students who did not look toward professional careers related to sci-

ence. The courses were variants in content, and organization of physics and chemistry, and, in a number of cases, the methods of instruction were also modified. Some of the courses were of the advanced general science type. Some were separate physics and chemistry courses, but with the stress on applications which were commonplace in the lives of the students. In some schools the offerings took the form of photography and aviation in which the principles and facts of physics were selected and organized in relation to a particular form of applied science. In some cases attempts were made to unify physics and chemistry and other physical sciences into a physical science offering, much as biology was derived from a unification of the several biological sciences.

During the early years of the war these courses were set aside in favor of regular physics and chemistry courses, and in order to introduce courses that stressed certain aspects which were considered important in preparing students for effective service either in combat or in producing and servicing specialized equipment. Pre-induction courses in fundamentals of machines, fundamentals of electricity, preflight aviation, and the like entered the high school science program. With the cessation of active warfare these courses lost favor. Likewise, many students who had elected to study physics as preparation for service lost this incentive, but the need for specialized personnel in industry caused others to continue their physics and mathematics training. Pre-induction courses have been almost entirely displaced, but many schools are continuing to offer one or more sections of aviation.

During the last two years a growing interest in various forms of modified physics and chemistry has become evident. Much of this interest seems to stem from school administrators who are sensitive to the science needs of students which are overlooked in the standard physics and chemistry courses. This presents to you as physics teachers an opportunity to plan content, organization, and methods of teaching in order to meet the needs of an increasing number of students. Many physics teachers have jumped to the conclusion that the best solution is another physics course which will put less stress on the theoretical and fundamental and more stress on the cultural and applied aspects. Without giving much consideration to the needs of the pupils as revealed by community surveys and occupational data, they want copies of courses of study as developed in other communities in the hope that they can make a change here and there and come up with the answer. If you feel that physics has greater contributions to make to the pupils in your school than what your current situation permits, may I suggest that you consider the following avenues of service:

1. Enter actively into the planning for science experiences which may enrich and vitalize the elementary school instruction. This will require that you work actively with administrators, supervisors, teachers, and pupils in attempts to make physics ideas functional in the lives of boys and girls. As an early step in your own preparation for this type of service you might study *Teaching Elementary Science—Suggestions for Classroom Teachers* by Glenn O. Blough and Paul E. Blackwood. (1)
2. Participate freely in planning experiences related to physics for pupils at the junior high school levels. Perhaps one of your best means of getting ready for useful service would be to assume responsibility for one or more sections of general science for a year, and in the process test your ideas in the crucible of experience. In general science, physics teachers will find one of the most fertile fields for making physical facts and principles function in a program of general education.
3. Work cooperatively and openly with the teachers of biology in order to help provide the physical principles, facts, and methods which are necessary for an understanding of biology. With the growth in various aspects of bio-physics, there is a need for much cooperative planning and working of physical science and biological science teachers.
4. Study carefully and without undue prejudice all aspects of your physics and chemistry instruction, and undertake experimental units and other modifications in order to search for greater usefulness of your specialty in the education of the youth in your school.

C. While the growth in enrollment of high school physics has been continuing more and more slowly, the growth in public appreciation for physics has made rapid growth.

People generally are appreciative of what science developments have contributed to (1) improving our standards of living, (2) increasing our agricultural and industrial production, (3) developing of weapons of tremendous military efficacy, and (4) improving and safeguarding human health. Physics occupies a rather unique place in making many of these developments possible. Based to a large extent upon the activities of physicists, the people of the United States recognize a need for more and more scientists who are competent to insure continued progress along several strategic fronts. In an appendix to the report of *The President's Scientific Research Board* under the chairmanship of John R. Steelman, we find the following statement:

> The United States now holds the scientific leadership of the world. However, it is a question, whether, even in the United States, there is a clear understanding of what science can do for and to mankind. Therefore, we must not only develop a corps of scientists sufficient in number and competence to insure continued progress but also make a concerted effort for mass education of our citizens in scientific principles and understanding. (2)

Later in this introductory statement we find the following rather clear indication of our responsibilities:

> The dual responsibility of insuring that we have (1) enough competent scientists to do whatever job may be ahead and (2) a voting public that understands and supports the scientist's role in defense and in the design for better living, rests heavily upon the Nation and all men of science in these fateful years. (2)

Physics teachers along with all other high school science teachers share in these dual responsibilities. Many of you are sensitive to your dual role. If you are like most other science teachers, you have a strong professional interest and you want to encourage and help those developments which make the best contribution to youth while making certain that the strengths of our standard physics and chemistry courses are not overlooked or lost.

I am certain that most of you feel that you do not now have the best chances to make your subject count in the lives of your students. You want to make a real contribution to the boys and girls who have what it takes to pursue scientific careers. You feel that you are hindered by students who are not particularly interested in physics and who do not grasp it readily. You feel that many students do not have the mathematical skills needed to understand physics and to solve physics problems. Too many students cannot or will not do the required work. There are too many students who hinder your efforts to help the students who can and will study physics. You feel certain that there is and should continue to be a place in the high school program for solid physics courses for the students who are looking toward scientific careers whether it be for teaching, research, or development planning. This is in accord with one part of our dual responsibility and it should not be set aside.

The general education aspect of our dual responsibility looking toward a scientifically literate citizenry is an area of great confusion. May I suggest that you give much thought to this problem and that you undertake well-planned experimentation looking toward the best answers to this second phase of our dual role. If wisely developed, the physics course will serve more clearly for the talented students while some alternative will meet the general education needs of all our senior high school pupils. The high school science subjects taken by the usual secondary school pupils are commonly general science and biology. Over and above this some students take physics or chemistry. Some students take both physics and chemistry. The majority of high school pupils get no physical science other than that incorporated in general science and biology. The question is this: Do general science and biology contain the necessary minima of what the physical sciences can contribute to general education at the high school level?

Many leaders in the planning of college programs consider that high school graduates do not have the necessary minima of scientific understanding and insight needed for intelligent living. Many such leaders think that no one year of laboratory science will bring these students up to the necessary minimum. They feel that if the students would study a first year college physics course they would miss too

much of chemistry, geology, astronomy, meteorology, and the like. In some institutions plans have been made for a general physical science course, but it has been difficult to avoid a fragmented offering. Some have proposed using the historical approach as the unifying theme; others have decided that the scientific methods and their utilization in various ways should be the central plan. The point to be made here is that leaders in educational thought have reached the conclusion that high school graduates who come to college have missed many of the general education values of science. What have we in the high school science field done to provide opportunities for general education through the sciences—through physics? If the students going to college have missed such education, what about those who merely plan to graduate from high school without meeting college entrance requirements? What about the pupils who drop out of school before graduation? Have we neglected an opportunity and a responsibility?

The problem of education for effective citizenship has been studied persistently and several major reports have been issued. A new approach to the problem was made in 1946 in a series of five regional work conferences which provided data and ideas for a national work conference held in Chicago in May 1947. This led to the appointment of a national Commission on Life Adjustment Education for Youth in which several major educational associations are represented. The Commission has held several meetings and has formulated a plan of action.

The goal of the Commission is to assist in increasing the effectiveness of present efforts through education to meet the imperative needs of all youth, both those in school but even more those who drop out of school. This is not a new goal but the approaches to the developments which may result are somewhat novel. Each State Department of Education has been asked by the Commission to select or designate a committee to encourage and assist schools that are interested in becoming development centers. The nature of the developments that have proved successful and the developments to be undertaken are to be carefully studied both by the local community and by the appropriate State committee. Promising practices are to be brought to the attention of the Commission which will serve as a clearing house for dissemination of helpful information.

It would seem that here is a framework for some of your planning, especially as it relates to the second facet of our educational responsibility; namely, education for effective citizenship. Perhaps you can encourage your administrators to establish a development center in your school. Perhaps you can demonstrate your own readiness to assist in the thoughtful planning and careful experimentation which

should result. If you can do no more, perhaps you can keep yourself informed of developments in Life Adjustment Education and try to think through what the implications may be for your work as a physics teacher.

Summary

There are two broad fronts for physics teachers to attack by careful planning and experimentation. One of these fronts looks toward improving the high school physics courses so that they will challenge the interest and efforts of more and more high school pupils. This will require planning and replanning of organization, content, and methods so that the subject will meet many and varied needs and abilities.

The second front looks toward providing alternatives to physics which will be organized and taught for the primary purpose of contributing to the scientific literacy and understanding of all senior high school students. Basic to such planning is a knowledge of what elementary science, general science, and biology can contribute. Other necessary bases are to be found in the needs of the high school pupils and the opportunities in the community and nation.

Physics teachers as well as other science teachers would be making their greatest contribution if they attacked on experimental bases along both of these fronts after developing thoughtfully prepared plans. There is more than a faint possibility that the changes which will make for increased effectiveness in meeting one of our dual responsibilities will also suggest ways to increase our effectiveness in meeting our other responsibility.

Cooperative work among science teachers, and between them and other personnel, appears to offer the greatest hope of finding successful solutions to the problems faced by physics teachers, school administrators, and high school pupils.

AIR LINE STEWARDESS

A new six-page pamphlet about the job of the Air Line Stewardess, by H. Alan Robinson, has just been published by Occupational Index, Inc. Released in September and based on information compiled from a survey of 15 commercial air lines, this leaflet is available from Occupational Index, Inc., New York University, New York 3, N. Y., for 50¢, cash with order.

It presents briefly, but thoroughly, an outline of the history of the work, its nature, future prospects, qualifications and preparation demanded by airlines, training, methods of entrance and advancement, earnings, numbers and distribution of workers, discrimination, unions, advantages and disadvantages. Included are an appraisal of the available literature, sources of further information, and a brief bibliography.

ARE OUR CITIES WORTH SAVING?*

CARL R. DORTCH
Indianapolis Chamber of Commerce, Indianapolis, Indiana

An ever growing awareness among our people of the necessity and desirability of conserving our vast natural resources and of reclaiming our beautiful and productive soil is due, I am sure, in no small degree to the attention given our country's conservation problems by such a group as this.

I wonder, however, if there is not now a need for such an awarenes among our people of the counterpart of such a problem in connection with our cities—among our great urban populace.

How many people do you suppose are concerned with the future of the city in which they live and work and earn a living? How many persons are aware of the fact that virtually every American city faces tremendous problems that jeopardize its future? How much time and effort have you spent in considering whether your city is worth saving—whether it is worth your effort to assist in solving problems that threaten its existence?

Just two weeks ago, a new and comprehensive plan of national civilian defense was announced to the American people.

However deep and fervent our hopes for a permanent and lasting peace may be, this somber report not only reminds us, of that fateful event at Hiroshima only three short years ago, but clearly calls for the best of our collective efforts in solving the problems of our new age—for certainly this is the cold grey dawn of the morning after.

My knowledge of this new scheme of national defense is limited to the coverage given it by our local press. I don't know the details of the Hopley report. I get only the general impression that as a vital part of our future military strategy and civilian security, it calls for the dispersal of strategic military plants—for the decentralization of industry for military reasons and might even conceivably suggest that we break up our great, but congested, residential centers for reasons of public safety.

This becomes important to you and to me. It appears that some significant changes might occur in our method of living.

No one knows, it is true, what the city of tomorrow will be like, any more than he knows what his personal life will be five or ten years hence. But just as a responsible human being uses his best judgment in planning for his future as best he can, so responsible persons interested in city development set about trying to forsee what the city of the future may be like in order to make intelligent plans for it.

* Presented at the Conservation Group meeting of the Central Association of Science and Mathematics Teachers at Indianapolis, Friday, November 26, 1948.

The interesting thing to me is that the advent of the atomic bomb and the resultant Hopley report only intensify interest and focus more attention for long-range planning on a problem that for some time now has plagued city officials and calls for the best thoughts of the sociologists, political scientists, fiscal experts, traffic engineers and practical politicians.

The disintegration of the American city is not a new phenomenon. Its symptoms have been with us for some time, but diagnosis and prognosis late in arriving. Only recently have people begun seriously to wonder if our cities are worth saving from the decentralization forces that have been at work for some time. However, I don't believe that our cities will fly apart and disappear, as some of these same people fear or predict. The over-all population pattern of tomorrow probably will not follow every concept of the Hopley report. From an aesthetic and military standpoint, it may be desirable for our urban population to live in self-contained communities of controlled size. There may be several such areas developed in the near future; and they may be charming places to live in. Certainly, this kind of development would curry favor with the idealist and the city planner. But, I can't forsee a great population change or shift that will solve the many municipal problems that exist *today* in New York, Boston, San Francisco, or in your city or mine.

Hence, it seems to me that our main task is not one of visionary, broad planning of our future cities, but one of recognizing the ills that have been created and growing with us for some time. Our job is to use our best talents and good judgment to cope with them as rapidly as we can.

These broad blueprints for our future economy and for re-planning our cities and towns of tomorrow generally suggest that we didn't have 20th century knowledge to fit together neatly our 19th century building blocks. But a certain amount of disorderliness may not be too great a price to pay for being alive and prosperous. A cemetery is neat and orderly and well planned. Moreover, it has been said that the reason why people in cemeteries occasion so little trouble, is because, generally speaking, they stay put. It is the people above ground who cause difficulty.

I suspect it would have been too bad for us, had our forefathers stayed put. Fortunately, they didn't. They created. They built a great, strong, wealthy country through their endurance, initiative and free enterprise. And in this age of motion and creativeness, we discovered full use for all the marvels of the past century—for the automobile, the airplane and mass transportation. People moved about, but these people in motion not only created a great nation, they caused also some difficulties.

Briefly, let's see what happened.

In 1790, ninety-five per cent of our people lived either on the land or in small settlements. The city was merely a concentration for trade, a clearing-house for news, a rallying ground for patriots. Even then the city was considered more a blemish on the fair face of democracy—full of immigrants and criminals and general rabble—then a political entity. But in the last hundred years the population picture began to change rapidly. American cities and towns began to grow like Jack's beanstalk. The excess farm population no longer required, under a mechanical age, to produce food for the nation, thronged to the cities for employment. By 1940, more than 56% of our people in this country lived in cities and towns of over 2,500 population and led an urban existence.

What problems did this change in our method of living develop? Look about you. They're tangible. They're here in Indianapolis, in Louisville, in Pittsburgh, in New York or on any Main Street in any American city. Most people recognize them.

Since November 2nd, I hesitate to mention the words "public opinion poll." But recognizing that such may have some validity other than electing presidents, a recent poll of voters in cities throughout our country conducted by Dr. George Gallup's American Institute of Public Opinion sheds some interesting light upon our municipal problems. In answer to the question, "What would you say is this city's worst problem today," the citizens over the country answered that the most discouraging city problems in order of importance were: (1) poor housing and slum areas; (2) exasperating trafic jams and parking headaches; (3) dirt and unsightliness, messy streets, smoke, slow garbage removal, inefficient sewage disposal; (4) high taxes, waste of government funds; (5) city government corruption; (6) lax crime control and law enforcement; (7) interracial tensions, and (8) juvenile delinquency.

So it appears that our American cities, having survived the industrial revolution, are of age and face the tremendous responsibility of maturity.

Here is where our immediate problem begins. I do not deny that American restlessness is changing the pattern of America. I do not suggest that material changes will not result from our concepts of national defense. I do not overlook the fact that there are in motion great dynamic forces which are increasing the mobility of the people and tending to change present concepts of our cities. I do believe, however, that such a listing of recognized problems constitutes far more tangible, immediate and challenging symptoms of trouble in our American cities and towns. Here are the real problems which plague our urban existence and threaten its ultimate destruction, as a

comfortable and suitable way of living unless they are solved.

If our cities are worth saving at all, here is where we must devote our immediate attention for corrective action.

These problems of smoke and dirt, slums, traffic jams, parking, crime, delinquency, health and sanitation have not gone unnoticed.

An overwhelming majority of our city officials recognize the problem and strive earnestly for corrective measures. Almost uniformly, however, their answer is that they are without the necessary resources to do the job that is required, to meet the new demands for services that have been piled upon them, to defray the increased costs that local governments also face. These public officials state sincerely and positively that local government needs more tax money than it is now getting to meet the eternal problem of paying the bill. I agree with them but I am equally earnest in believing that more money is not the sole answer to the present difficulties. We shall discuss this later.

Right now let's examine why our cities are in a financial squeeze at a time when all government—federal, state and local—is extracting from its citizens nearly one-third of their annual income.

Not many years ago, as late as 1932 in fact, local government gauged by its tax requirements, was the most important of the tax collectors. In that year, its revenues, exclusive of state or federal aid, was $4.4 billions. The 48 states called for $1.8 billions to support their activities and the federal government raised $1.9 billions. Today the picture has changed drastically. The federal government takes $42 billion from its citizens—an increase of more than 2,000 per cent. State governments call for $8 billions, an increase of nearly 350 per cent. Local government gets $7 billions or an increase of only 60 per cent.

The story of what happened in these years at the state and federal level, is well known. The federal and state governments flexed their muscles, and having the authority, created new or increased taxes to meet tremendous demands for welfare and defense and war expenditures. A new look also appeared. One echelon of government began to seek grants-in-aid or tax reliefs from a higher level of government. Thus, we had a new rash of state aid to local governments, and federal aid to state governments.

Right here let me say, as an aside, that as far as federal aids are concerned, the future picture based upon the logic of sound finances—not political promises—looks discouraging indeed, particularly for those who hope Uncle Sam can continue to provide, out of some bottomless pit, the answer to their pet projects, whether it be some special works program, or federal aid to education, or federal aid to rat control or some other purpose, however noble or laudatory. Here

is why I say this, and it is based upon some personal observations of federal finances. The federal budget now calls for expenditures in the 1949 fiscal year of something like $42 billions. However, based upon existing commitments and policy decisions for present federal programs and national defense (exclusive of those promised before the first Tuesday of November) the federal government wlll be spending in the 1951 and 1952 fiscal years *not* $42 billion but right at $52 billion. As long as we are committed to a national defense program of the size and scope now planned, Uncle Sam has his nose pretty well to the grindstone without searching for the wherewithal to support additional programs at the state or local level.

But back to the local picture. What has happened to our cities and towns, while the state and federal governments were extending themselves into new fields of governmental activity? Well, for the most part, after a brief respite because of shared revenues in the middle 30's, they were raising their property tax rates. They had no other place to go. For while state and federal governments were preempting new fields of revenue, with new income or sales taxes, the cities found themselves in a financial straight jacket. As a creature of the state legislature, local government may govern and support itself only as the state cares to dictate and the only major means available has been the property tax. In the face of revived demand for adequate municipal services, occasioned by the return from war to peace, it has been totally inadequate. The property tax simply has lost its fertility. As the old grey mare of our local taxing system, it is inadequate to meet any further the demands of the modern municipality.

Is it any wonder then, that the financial plight of the cities has become a rather common phrase? Is it any surprise to find that operating deficits are almost a general rule, rather than an exception in many of our American cities? Is it unusual to report that cities all over the country are searching for some available means of raising more revenue to provide for normal city services? Is it a shock to discover that some local units are being granted almost unlimited taxing authority, and that a rash of city sales taxes has broken out in California and in other parts of the country? Or that a new phenomenon in city finances—the payroll withholding tax—has been, or is in the process of being adopted, in Philadelphia, Toledo, Columbus, Louisville and in scores of smaller Pennsylvania communities, and is being eyed hungrily by starved cities throughout the nation?

When, in Indiana, the unsatisfactory property tax is still being more widely used to support local government (as much as 75 per cent in Indianapolis) than in most parts of the country; when tax rates that normally were considered high at $3.00 per $100 of assessed valuation, have risen to $5.00 and $6.00, is it any surprise to find

that cities in this state have a financial problem and that this is likely to be one of the major issues at the next session of the Legislature?

What, then, is the answer? Well, as previously indicated, the eventual solution does not rest with purely financial considerations. In return for the additional tax support that citizens may be expected to grant our public officials to meet their newly created problems, most of us appear to believe that taxpayers have every right to expect something better than they are accustomed to receiving in return. There is always room for economy and efficiency in government. This is a *first* and *must* order. Further, our local civil governments generally throughout our country will not be of the highest, most effective order, in spite of any new avenues of revenue that might be afforded them, until they have modernized its present pattern of organization and administration.

Specifically, I mean that our cities and towns to cope effectively with our modern, urban city economy eventually must:

First: Provide a modern form of efficient local government, responsive to the desires and demands of its citizens. We should have enough faith and hope in our democratic system to believe strongly that the inhabitants of our cities and towns should have the right to determine their form of local self government. Modern urban living with all its complex problems of health, sanitation, engineering, recreation, redevelopment, planning and financing, has need of the best form of operation and administration that modern science can provide. Specifically, the management of our cities of today calls for a counterpart in government to that of the professionally trained, experienced manager of a large private corporation. At least, every city ought to be permitted, not prohibited, this opportunity of local governmental administration and organization, if its people want it.

Second: The time has come for local government to accept some lessons in personnel administration from the field of private employment. More than ever a comprehensive personnel program to improve the quality and capacity of our public employees by a well rounded, unified program of recruitment, classification and pay, supervision, promotion, and tenure is needed. There is no Democratic or Republican way to repair or pave a street, to fight a fire or to pound a typewriter. City government is too vital to our daily well being, to turn it over to anything other than competent people who are selected for what they can do, rather than for whom they know. To those who say political patronage is a vital adjunct of local government, I say "Get Awake." Look around you. You will find that many well run cities and towns do not clean house every time there is a change of administration. The task of running a modern city is a complicated

one. It calls for professionally trained, technically qualified people, whose conditions of employment should not be subject to the whims of partisan politics.

Third: Good local government has need of the best tools of management. There is a general need for more business-like methods in such important activities as purchasing or financial accountability. My knowledge of such important governmental activities leads me to believe that local government has much to learn—and much to gain—from better inventory controls, financial planning, cost accounting, volume purchasing and warehousing than it is now using. Unless we improve our systems of operation, it will not be surprising to see financial chaos keeping company with management chaos.

Fourth: It is essential that some antiquities in our form of local government either need to be eliminated entirely or drastically revised. In this category, we should thoroughly review and consider a substantial overhauling of our local township systems that exist in large numbers throughout our country. Their deficiencies in relation to an adequate, modern school system are well known. Their shortcomings in relation to the equitable assessment of property and uniform administration of poor relief, particularly in the larger urban centers here in Indiana border on the ridiculous and should not be perpetuated. The research material that comes across my desk daily indicates a similar situation in many of our great mid-western states.

Fifth: We need to provide ample funds for the adequate operation of our local affairs. There is convincing evidence at hand to indicate that enough taxes are being paid today; that 31 cents out of every dollar to support government is a big bite out of our personal income. The fundamental problem appears to be one of outlining proper fields of governmental activity and distributing our tax dollars accordingly. Some day, I am hopeful that someone with enough intelligence and authority will be able successfully to define these fields of activity for our federal, our state, and our local governments and to assign to each the necessary financing authority to do the kind of a job that is required. I am convinced that we suffer financially and morally in leaning upon a higher level of government for the performance or financing of local problems. My personal observations of the budget making process at both the federal and local level convince me that the tax dollar loses importance and effectiveness when it flows through and out of Washington for expenditure upon matters that should be met at home by local taxation.

Sixth: We need to recognize frankly the problem of the fluid city—the creation of bedroom communities in suburban areas. Let us have done with the kind of talk that describes as "evil" the outward movement from the city—of man's desire to breathe fresh country

air, to feel sunshine, and to plant his radishes and lettuce on his own little plot of ground. We cannot and should not try to stop this outward flow. Instead, let's cement the relationship of the central city to its neighbors either through an orderly, coordinated system of annexation or by the device of metropolitan government designed to secure the health, safety and financial future of all of those who live and work within the area. If we don't, there are distinct dangers ahead. The disintegration of Boston, physically, financially and politically, is an example. Because there wasn't an early recognition of this problem, Boston was surrounded and choked by independent suburban areas. Gradually, Boston deteriorated. It lost its property values and its position as the greatest of eastern seaports. Even in this historic city, there was a distinct loss of community spirit. But what is equally alarming, Boston lost its political fibre, for in the recurring election of its Mayor Curley, there is a sad moral, only one out of every five resident voters owned property within the limits of the central city.

Let us forsee that while there will always be a substantial resident population in our cities, more and more of our people will live elsewhere and will come to the city to buy and to sell, to work, to worship and play. Hence, the new type of city which appears likely to emerge within the next few decades may not be primarily a city of homes, but of business centers, markets, schools, churches, theaters and civic buildings.

Perhaps the city of the future will be a less sharply defined political entity than the city of today. Suggestions of a new type of metropolitan government embracing the central city, satellite cities, suburban fringes and even contiguous rural areas already have been put forth by thoughtful persons. A new pattern of local government must of necessity be evolved to fit the new type of urban city economy. We cannot long permit the bedrooms to be separated from the counting rooms in our governmental structure. Where we work and earn our living is just as important to us as where we live and relax, and these should not be separated by artificial barrier that for decades have been confused and complex. Annually, our local government becomes more so. Probably no one is wise and forseeing enough at this point to outline in clarity and detail a logical structure of local government for the future, but the problem demands the best thought of our authorities on governmental organization and administration.

In the meantime, let us work with the strong conviction that our modern cities are not doomed. We are in a transitional period, it is true. But there will be no great exodus of industry and people to the wide open spaces. Great cities such as New York, San Francisco,

Chicago, and yes, Indianapolis, or your home town will be on the map, altered, but recognizable for centuries to come.

So it behooves us, every one of us, to work in solving the problems which make our present urban living vexatious. We must find the answers to the dirt, smoke and messy streets of our cities and towns. We must provide better services for the health and sanitation of our communities. We must solve our traffic and parking headaches, our housing problems. And, in finding the answers, we must provide the revenue to do the job.

How high can property taxes be on homes without becoming ineffective? How can the property tax be supplemented, and by what methods of local revenues or charges? Should there be a shift of responsibility for certain public services from local to state government and from state to federal government? What is the maximum debt that cities can afford for public improvements? What should be the form of local government that recognizes the fluidity of our modern cities?

These and like problems are not theoretical. They are real. They are pressing.

It has been said that democracy "will die at the local level if local government cannot continuously supply essential services of high quality at reasonable cost." If democracy fails in the cities and towns of America, can it do anything but fail all over? Therefore, to a great extent, the safety of the American form of government also rests on the soundness of the government in its local units.

The vast majority of our people come in direct contact with only local governments; and their confidence in our governmental system, as a whole, depends largely on the character and integrity of those governmental institutions which they see and feel and understand.

I am sure prospects for a better, greater local government are abundantly in evidence. They are geared, however, to the continuance of good local government and you must not allow it to deteriorate through either insufficient revenues or an overburdened property tax structure, or citizen apathy. Your understanding of the problem is important. Your active interest in your most valuable civic possession is necessary. Your city government holds the infinite promise for the happiness and prosperity of you and your neighbor. It is too vital to ignore or to kick around. A "Let Joe Do It" attitude is the best way to surrender your rightful heritage to all the benefits and privileges it has to offer.

Elihu Thomson, the inventor of the kilowatt hour meter and a host of other electric devices, was born at Manchester, England March 29, 1853 but came to America with his parents five years later.

SERIES AND PARALLEL RESONANT CIRCUITS

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The series and parallel resonant circuits are two important phases in the study of radio. Both are to be found in the modern radio as tuning circuits and as wave traps, and play an important part in the broad and rapidly expanding field of electronics. It is therefore imperative that instructors demonstrate these opposing actions as forcefully as their laboratory supplies will permit. In many cases, distressed school districts find it impossible to stock their laboratories with the required equipment, and therefore the teachers are left to improvise with what meager supplies they have on hand. It was this situation which led me to devise a method which I thought was unique, simple, and inexpensive. For this reason, I would like to pass it on to others.

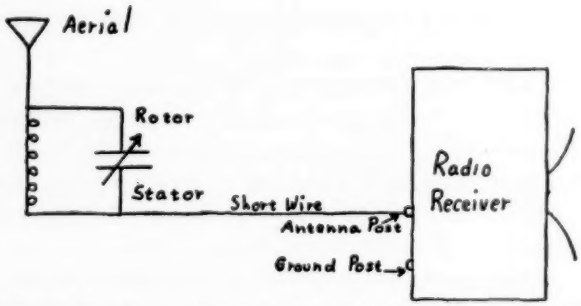

FIG. 1. Coil and Condenser Connected in Parallel with Each Other and in Series with Aerial and Antenna Post of a Radio Receiver.

First in considering the parallel resonant circuit, it must be understood that the characteristic effect is to produce a tremendous amount of resistance to a current whose frequency is in resonance with that of the tuned circuit. Simply stated, little or no current will pass through the circuit at resonance. To demonstrate this effect, procure an old R. F. coil and a conventional tuning or variable condenser. Connect these as is shown in figure one. Notice that the coil and condenser are connected in parallel, and that the rotor side of the condenser is condenser is connected to an outside aerial. The stator side is connected to the antenna post of an ordinary receiver requiring an outside aerial. The wire in this connection should be as short as possible so as to prevent its picking up radio waves. If it should be found undesirable to use a short wire, use a shielded cable similar to that used in microphones. In this case the shielded part, or outer braided part, will be grounded to the radio chassis or ground post.

With this arrangement you are prepared to demonstrate that a given radio frequency will, at resonance, be blocked out, and no current from the antenna will be fed to the radio receiver.

First, tune in any radio station on the receiver. With the volume turned slightly above normal, turn the variable condenser slowly until you reach a point where radio reception ceases. Now the parallel resonant circuit is in resonance with the incoming radio wave, and the net effect is to block it out completely as evidenced by the fact that radio reception had ceased. By turning the variable condenser of the parallel resonant circuit slightly, radio reception will be again restored, thus proving that at resonance, a parallel resonant circuit offers almost infinite impedance to a wave whose frequency is the same as that to which the parallel resonant circuit is tuned.

To demonstrate the series resonant circuit, which in effect is the opposite of a parallel resonant circuit, connect the coil and condenser as shown in figure two. Proceed as you did in the previous demonstra-

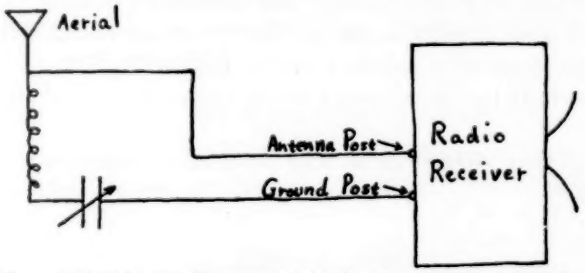

FIG. 2. Coil and Condenser Connected in Series with the Aerial and Ground Posts of a Radio Receiver and Aerial Connected Directly to Antenna Post of Receiver.

tion tuning in a station on the radio. With the volume at normal, turn the variable condenser of the series tuned circuit, and again reception will cease. The explanation for a series resonant circuit is that it offers an almost free path to R. F. currents to which it is resonant. In this case, all the R. F. current coming from the antenna passes freely through the resonant circuit and then to ground where it is dissipated. It is interesting to note here that the series resonant circuit offers an easier electrical path than does the solid wire leading from the antenna to the antenna post of the radio.

SIDELIGHTS

1. Note that at resonance either circuit will reject but one frequency and pass all others. (As shown in figures 1 and 2)
2. Note that the frequency to which either resonates increases as the capacitance of the condenser decreases.
3. Note that the parallel resonant circuit rejects the wave to which

it is tuned, whereas the series resonant circuit passes freely the wave to which it is tuned.

4. Note that if the wire lead to the radio from the stator of the variable is too long, it will act as an antenna and thus prevent the proper operation of the parallel tuned circuit.

5. Note that if the rotor and stator plates are not connected as shown in the diagram, body capacitance will affect the proper operation of the circuit.

6. Note that the radio receiver serves as an indicator of resonance.

7. Note that the frequency to which the radio receiver is tuned (the radio station being received, WJZ, WOR, etc.) is the same frequency to which the circuit resonates.

8. Note that frequency affects resonance.

9. Note that capacitance affects resonance.

10. Note that inductance (coil) affects resonance. This can be done by providing a sliding contact on the coil so as to change the number of turns of wire and thus change the inductance.

11. Note how all effects can be demonstrated to fulfil the requirements of the formula f equals $1/6.28\sqrt{LC}$.

12. Note that by varying any of the above (8, 9, and 10) we affect resonance.

13. Note that either circuit can be used to *measure* unknown capacitances.

WILEY ANNOUNCES "STRUCTURE OF MATTER" SERIES

John Wiley & Sons, New York, began publication this month of a new series of advanced monographs on the structure of matter, according to an announcement of the publishers. The collection of monographs, written by outstanding contributors to current thinking and new developments in the many scientific fields concerned with structural phenomena in matter, will be known as the "Structure of Matter" series. Dr. Maria Goeppert Mayer of the Institute for Nuclear Studies at the University of Chicago has been appointed editor of the entire program.

To introduce the series, Wiley published "The Structure of Matter," by Francis Owen Rice and Edward Teller, on January 3. Dr. Rice is head of the chemistry department of the Catholic University of America, while Dr. Teller is professor of physics at the Institute for Nuclear Studies and at the University of Chicago. Their book summarizes the results of modern theories of structure of matter and shows the scope of the phenomena explained by quantum mechanics.

The series will continue over several years with monographs on more specialized aspects of the structure of matter. Manuscripts already in preparation include a treatise on the separation of isotopes, by Harold C. Urey and Karl P. Cohen; a book on superfluids, by Fritz London; and works on shock waves, solubilization, structure of liquid crystals, and experimental aspects of low temperatures.

SIGNIFICANT TRENDS IN SECONDARY MATHEMATICS*

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According to the dictionary "trend" means "to have or to take a general course or direction, incline." Some trends may be good and some may be bad. Some may be significant and others may be transient and ultimately disappear. For our purpose it will suffice to consider those trends good or bad that seem significant enough to warrant our attention at this time. However, it is clear that in the short time at my disposal I cannot discuss all of the possible trends. I shall, therefore, confine myself to those that are most obvious and which at the same time need further study. It should then be our duty as leaders in the field to support the trends that seem to be good and to discourage, if not deliberately oppose, the bad ones. It is only in this way that we can determine the best teaching procedure for the secondary school.

I. GOOD TRENDS—TO BE ENCOURAGED

Trends may also be classified into those that are more general and those that apply to more specific subjects like arithmetic, algebra, and geometry.

1. *General Trends*

a. *Meaning vs skills.* One of the most common general trends today is that of placing more emphasis upon meanings or understandings and less on skill or automatic functioning of rules or principles. This is particularly true in the field of arithmetic.[1] But many teachers of algebra and geometry are also aware that meanings must be stressed if pupils are to get the most out of their study of mathematics. For example, we all know that many pupils who can get correct answers to problems in algebra or give satisfactory proofs of theorems in geometry have little understanding of what it is all about.

b. *General mathematics.* There is no question but that there is a definite trend to organize the curriculum along general mathematics lines. This is as true now of the first year of the college as it has been for some time in the secondary school. And this is as it should be, but some of us would like to see the job done better. What is called "general mathematics" by some teachers and authors is surely no improvement on the old water-tight compartmentalized type of teaching and

* Read at the Mathematics Section of the Central Association of Science and Mathematics Teachers at Indianapolis, November 26, 1948.

[1] See the tenth and sixteenth yearbooks of The National Council of Teachers of Mathematics for a very fine discussion of this matter. The tenth yearbook is now out of print, but the sixteenth may be had from the Bureau of Publications, Teachers College, 525 West 120th Street, New York 27, New York. Price $3.00 postpaid.

it is not even general mathematics in the best sense. I enlarged on this point in my other paper this morning; so I wlll not discuss it further here except to say that we must kill the notion that too many teachers have that "general mathematics" is a course for "boneheads," or dull normals. And we must see to it that satisfactory textbooks in general mathematics be prepared to meet the needs of pupils in grades 7 to 12 inclusive.

c. *Individual differences.* Individual differences in ability among pupils are now generally recognized, but little is being done to reorganize the content material for teaching purposes to meet them. For example, we have been advised by leaders in the field and, notably, by the Commission on Post-War Plans in its "Second Report" about the importance of a "second track" for pupils not going to college, or at least for pupils for whom the traditional course in mathematics is neither of interest or of much value. I would even venture to suggest that there should be three tracks, but I would be in danger of being attacked by most of the publishers of textbooks who think they are going to have trouble enough with a two-track system in mathematics much less three. And that is not all. Pupils differ not only in ability to do mathematics, but also in experiences and interests and we have done little in regard to these points in our reorganization of content material for teaching purposes. Homogeneous grouping for teaching purposes is one of the best methods of handling individual differences, but some people oppose it because they think it is undemocratic. I think it is very democratic, because in a democracy we need leadership and in our schools we do not do a very good job in training leaders. We are all geared up for the mediocre. The most retarded pupil is the gifted pupil. We can partly allay the fears of some people by making sure that in the main stream of knowledge we guarantee that the pupils have common experiences (the democratic way) and that enrichment in mathematics be offered for those who are able to take it. This is not bad, but we are not doing it generally.

d. *Multi-sensory aids.* The eighteenth yearbook[2] of the National Council of Teachers of Mathematics is evidence that there is a strong trend toward the use of multi-sensory aids in teaching mathematics in order that pupils may get a better idea of the material they are supposed to learn. However, much remains to be done. Moreover much of what has been done needs to be better organized and made more readily available to classroom teachers. We practically have no good moving pictures that we can recommend at the present

[2] and [3] The Eighteenth and Twentieth Yearbooks of the National Council of Teachers of Mathematics may be obtained from the Bureau of Publications, Teachers College, 525 West 120th St., New York 27, New York. Price, $3.00 each postpaid.

time although several groups have been at work upon them for many years now. We didn't learn as much from the Army's use of films as we expected in spite of the fact that some of these films served the purpose for which they were intended.

e. *The metric system.* The twentieth yearbook[3] of the National Council of Teachers of Mathematics in "The Metric System of Weights and Measures" shows another trend that has some chance of being made permanent. However, a great deal more work will have to be done before we can get rid of the awkward imperial system.

f. *Teachers' salaries.* The public is now aware that teachers are underpaid and that as a result, large numbers of them have left the teaching profession for more remunerative employment and that many schools have a tragic shortage of teachers which amounts to a national calamity. We need to insist that salaries of teachers be increased at once, but at the same time we should insist that standards for teaching be kept at a high level of excellence.

2. *Particular Trends*

When we come to particular trends that are good and should be made secure we find a longer list than one might expect, especially when he understands the "dead hand of tradition." Not that what is traditional is wholly bad—it is not. But we all know how hard it is to get something out of a course of study or syllabus once it gets in, though in fact it may have outlived its usefulness.

a. Omissions and additions in algebra

(1) *Factoring.* How true the last statement above is can be seen when one stops to consider how hard it has been, particularly in elementary algebra, to get factoring trimmed down to proper proportions. In elementary ninth grade algebra we can no longer justify more than two or three types of factoring, namely, taking out a common monomial factor, a perfect trinomial square and the difference of two squares. For most pupils, the first type named above would be sufficient, because the only place that the pupil needs to factor is where he wishes to put some formula in better shape for computation. Most of the types you and I had to study are now obsolete. We simply are not realistic about making the trend to delete obsolete material universal. In many schools the "deadwood" still clutters up the landscape to the detriment of all concerned.

In the research work done recently by some of my advanced students at Teachers College they found practically no need of factoring beyond the first type mentioned above. If some college professor ad-

vocates that factoring be taught in the ninth grade because as students in his calculus class they will need it, the answer is "let the college professor teach whatever factoring type he needs when the need arises." The need never has been so great as some people think anyway. It would be of interest to many teachers of algebra to read Heller's study[4] on the history and development of the topic of factoring in order to see how the topic got into the algebra course.

(2) *Complicated polynomial operations.* There is now no longer any need for the old complicated polynomial operations that used to occupy so much space in elementary algebras and yet some of the textbooks could still improve their present offerings in this respect. These have little value, if any, in a modern course in algebra.

(3) *Difficult material that is not functional.* If one should ask "What is the most difficult fraction or fractional equation one should teach to a ninth grade class in algebra?" the answer is "Look at the hardest formula he will have to understand and manipulate and you have the answer." It is our business then to find out what these formulas are and then act accordingly. The formula for the Centigrade-Fahrenheit conversion may well represent the height of difficulty for the ninth-grade pupil in algebra.

(4) *Algebra—a way of thinking.* Another trend that is all to the good is that of teaching algebra as a way of thinking. For the most part, algebra has been taught on a purely mechanical level, but many teachers who have been reading and otherwise improving their outlook are trying to show their pupils how algebra is a way of thinking.

The formula is now considered to be the main use of algebra—not the equation as formerly supposed. The equation is only subsidiary to the formula and as such should play a secondary role.

(5) *Arithmetic and numerical trigonometry.* These two topics are now pretty generally agreed upon as vital.

b. Omissions and Additions in Geometry

There are several clearly discernible good trends in the teaching of geometry in the schools.

(1) *Postulation of proofs by superposition.* We already have one or two textbooks which no longer include these proofs and doubtless they will soon be omitted altogether from the textbooks. Along with this trend should be another one which would not start the course with the topic of "Congruence." It will be easier with superposition proofs omitted, but it is still too hard where it now comes in the course.

(2) *Solid geometry included.* Some solid geometry is sure to be included in the newer courses and textbooks. This has already been

[4] Heller, H. F., *Evolution of Factoring*, Berwick, Penna., 1940.

begun. Why should we live in a world of three dimensions and teach, for the most part, "the geometry of flatland"?

(3) *Life thinking stressed.* Where one is asked why geometry is taught, a frequent reply is "So that the pupils can learn to think." But do they? The trend now is to bring in some life thinking along with the regular book work and the scheme seems to have been successful in certain schools. Fawcett's work[5] has undoubtedly had a great influence upon the thinking of teachers and text book writers in regard to this matter.

(4) *Reduction of the number of proved propositions.* There is a trend to materially reduce the number of proved propositions. Teachers interested in this trend should read Pickett's study.[6] There certainly is a chance to increase the number of original exercises which after all constitute the main source for the development of what we call "mathematical power." I once heard David Eugene Smith say in class "We could postulate all but two theorems in geometry and still have a very satisfactory course. Those two theorems are the one about the sum of the angles of a triangle and the Pythagorean Theorem."

(5) *Principle of invariance.* There is a slight trend to give more attention to the principle of invariance in geometry and this should be encouraged, but there is as yet little help for the teachers in current books in general.

(6) *Geometry—a way of thinking.* One trend in geometry as mentioned earlier is to teach geometry as a way of thinking, but it is only a trend insofar as most textbooks are concerned.

(7) *Some analytic geometry should be included.* The tentative Regent's Syllabus in New York State advocates the inclusion of an introduction to analytic geometry in the regular geometry course. While this is not a new idea it is a good one and other syllabus makers should give it some consideration.

(8) *Practical applications.* One trend that is really more than a trend is the present tendency among textbooks to include more practical applications. A great deal has been learned from the experience of men and women in the services about the work aerial and marine navigation. In these and in other fields like meteorology and the like we will find more and more applications of mathematics that can well be introduced into the geometry course.

II. Bad Trends—To be Discouraged

Perhaps we should not spend so much time looking for bad trends so as to advertise them. Someone has said "Never advertise your

[5] Fawcett, Harold P., Thirteenth Yearbook of The National Council of Teachers of Mathematics, Bureau of Publications, Teachers College, 525 West 120th Street, New York 27, New York. Now out of print.

[6] Pickett, Hale, *Proofs and Solutions of Exercises Used in Plane Geometry and Tests*, Bureau of Publications Teachers College, 525 West 120th Street, New York 27, New York, 1938.

enemies." Perhaps not, but we should know what these trends are and what may be done to minimize if not to eliminate them.

1. *General Trends*

a. *Omission or postponement of certain topics.* While the omission altogether or postponement of certain types of factoring in algebra is a good trend, it is equally true that some educators have done us a disservice by advocating the postponement of certain topics particularly in arithmetic. But it is true even in the secondary school. And the doctrine of postponement has kept out of the ninth and tenth grades particularly many topics that would be not only of great interest but of real value to many pupils. Here again is where we need to give more attention to individual needs and differences. It is only recently that a pupil in the ninth grade was able to get any help in learning how to measure indirectly (scale drawing and numerical trigonometry) in spite of the fact that he faces the problem in all kinds of life situations. One reason for this attitude is that teachers and textbook writers have thought that the various compartments of subject matter were air-tight. Here is where a good course in general mathematics can make a real contribution. The trouble is, however, that although teachers pretty generally now are willing to concede the value of a general mathematics course running through grades 9–12 they cannot find a suitable series of textbooks that are of any help to them.

b. *Leveling down instead of leveling up in content.* There has been a tragic tendency in our schools to "level down" as Bagley once put it instead of "leveling up" as it should be. The tendency is to "sugar coat" to try to make things easier. Making things as simple as possible is a good thing to keep in mind, but some supposedly difficult tasks can be made relatively simple by better organization of content and improved methods of teaching.

c. *Employment of unqualified teachers.* The present tendency to employ unqualified teachers because of the present shortage is to be condemned. While the need for teachers now constitutes a national emergency, a poorly qualified teacher may be worse than no teacher at all.

d. *Teaching glorified secondary mathematics to college students.* I hear on the best authority that many of the colleges and universities are teaching their freshmen at best only glorified mathematics. And what is even more unfortunate is that they are giving college credit for it. You can see how elementary most of this work is by looking at some of the newer texts of which there are many.[7] Of course the col-

[7] Brown, Kenneth E., *General Mathematics in American Colleges*, Bureau of Publications, Teachers College, Columbia University, New York, 1943.

lege authorities may in a sense be helpless. They are obliged to take the students that the secondary school sends them. Many of the present freshman population in the colleges and universities have had no training in many topics that really should be presented to them in high school where it could obviously be taught more effectively. The way to remove this handicap and loss to the students and colleges is to teach more not less of the basic ideas of mathematics in high school and let the college and university professors spend their time on real college work.

2. *Particular Trends*

When it comes to particular trends that should be avoided it is probably true that no two people would agree fully. What one teacher might think a certain trend should be encouraged another would think it should be opposed. Moreover there are so many ways in which undesirable habits and ways of going things creep into one's teaching that it would be hard to enumerate them all. A few examples must suffice.

a. *Mechanical teaching.* Although I indicated earlier a trend to teach for understanding rather than for mechanical skills, some teachers stlll teach transposition, cancellation, clearing of fractions and the like in a most mechanical fashion. I recently visited a teacher who was trying to show her algebra pupils how to solve simple equations—first type at that. She said "Now children, how would you start to solve the equation $x+4=10$?" Of course they didn't know. Why should they? She then replied "Well, you see it is just like this. When you cross the river you are different, put the 4 on the other side of the equation and change the sign." I am afraid there is still a great deal of algebra teaching just as mechanical and meaningless as that was. The late Professor Earle Hedrick used to wax eloquent against the dead hand of formalism. In geometry there are still too many teachers relying on memoriter methods. Not long ago I visited a class in geometry and when the teacher called on a girl to prove a certain theorem she replied "I'm sorry, but I can't say that one." That girl was honest if not a scholar. She meant just what she said. She had not yet been able to memorize the theorem.

b. *Conflicting theories about best methods of organization and teaching.* In these days when too many people are trying to curtail the offering in mathematics, teachers of that subject need to get together on a good course of study in mathematics with some agreement as to what are the best methods of teaching. We still have too much bickering and conflict in many local groups and often between various groups. It would be a salutory thing if short conferences of leading teachers could be held all around the country to try to get better agreement as

to what mathematics should be taught to various types of pupils.

c. *Tendency to ignore or fail to support various mathematical organizations.* There are many teachers of mathematics, and they are not all in the backwoods, who do not even know that the Central Association of Science and Mathematics Teachers or the National Council of Teachers of Mathematics exist. There are others less benighted perhaps who know about these and other less national organizations but who neither belong to such groups or read their official journals. There are still others who, although they are somewhat alert, manage to keep abreast of what is going on by reading the official journals in the high school library or some one else's copy. Such teachers do not realize how much their failure to support mathematics organizations, both local and national, is retarding our best efforts. No club or organization is any stronger than that indicated by its membership.

d. *Failure of teachers to obtain in-service training.* There is no reason why a teacher of mathematics or any other subject should feel that his training is complete when he has received an A.B. or an M.A. degree. And yet there are many teachers who at least act as if this were so. Some of them have not taken any courses for improving their outlook for years. Some do not even attend important meetings held in their own backyards. It is time that standards be raised not only for teachers preparing to teach but also for those already in the service!

Finally, it is obvious that one cannot in so short a time give anything but a most superficial view of significant trends, but I hope I may have given enough to start some discussion among various groups.

NEW BOOKLET ON ELECTRICAL POWER PLANTS

A new 30-page booklet entitled "Highways of Wire," by A. C. Monteith, Vice President in charge of engineering, has been prepared for distribution by the School Service Department of the Westinghouse Electric Corporation.

In this booklet Mr. Monteith discusses the basic component parts of a typical power plant—generator, transformer, circuit breaker, substation, etc.—in terms understandable to students. He traces the path of electric current from the generating plant, through the transmission lines, through the various stages of voltage reduction, and on to the ultimate consumer. Also touched upon are the final uses of electricity in the home, on the farm, and in industry. A few of the major problems which confront system operators and engineers are also discussed—problems such as voltage drop, short circuit, lightning disturbances, etc.

Numerous installation photographs, line diagrams, and cutaway views further explain the power system and add to the usefulness of the booklet. A double-page pictorial diagram located in the center of the booklet will be of especial assistance in the interpretation of a power system. The final page of the booklet contains six problems which can be used as classroom projects if desired.

Teachers can secure copies of the booklet by writing to the School Service Department, Westinghouse Electric Corporation, 306 Fourth Avenue, Box 1017, Pittsburgh 30, Pa.

THE ELEMENTARY SCHOOL SCIENCE LIBRARY FOR 1947–1948

PAUL E. KAMBLY

University of Oregon, School of Education, Eugene, Oregon

This fifth list of reference books for elementary school science supplements the previous listings.[1] The sub-division topics, similar to those previously used, are of no significance except as an aid in grouping the references.

The grade levels indicated are the lowest in which it is recommended that the books be used. These recommendations and the brief annotations are based on an examination of each book listed. The prices indicated are subject to change.

REFERENCE BOOKS FOR ELEMENTARY SCHOOL SCIENCE

Animals

(See also list of books on birds and insects)

	Grade	Price
Come to the Zoo. By Ruth M. Tensen. 26 pp. '48. Reilley*.... A book which first graders can read. A first-grade teacher herself, Miss Tensen has adapted the exact vocabulary the child learns in his pre-primers to a beautifully illustrated book to be read at home. The 43-word vocabulary is used in the simplest of sentences.	1	$1.75
Rabbits. By Herbert S. Zim. 63 pp. '48. Morrow..... Tells about cottontails, jack rabbits, and the many other varieties, both wild and tame. The text is printed in large, clear type.	3	2.00
Mr. Peck's Pets. By Louise Seaman. 96 pp. '47. Macmillan... Dogs, guinea hens, racoons and chameleons are some of Mr. Peck's Pets.	4	2.00
Amik. (*Life Story of a Beaver*). By Luis M. Henderson. 159 pp. '48. Morrow..... The story of a first-rate engineer whose early days are preparation for his job as a cooperative builder of houses, dams and canals.	5	2.50
Our Animal Friends and Foes. By William Atherton Dupuy. 285 pp. '48. Winston..... A reference book for good readers.	5	1.52
Tracks and Trailcraft. By Ellsworth Jaeger. 381 pp. '48. Macmillan..... Includes information about fossil tracks as well as tracks of many modern living creatures. There are numerous clear pen and ink sketches of tracks.	5	3.95
Vulpes, The Red Fox. By John and Jean George. 184 pp. '48. Dutton.....	5	2.50

[1] Kambly, Paul E., "The Elementary School Science Library," SCHOOL SCIENCE AND MATHEMATICS, 44: 756–767. November, 1944. "The Elementary School Science Library for 1944–45." SCHOOL SCIENCE AND MATHEMATICS, 46: 13–16. January, 1946. "The Elementary School Science Library for 1945–46." SCHOOL SCIENCE AND MATHEMATICS, 46: 865–870. December, 1946. "The Elementary School Science Library for 1946–47." SCHOOL SCIENCE AND MATHEMATICS, 48: 202–205. March, 1948.

* Publishers and their addresses are listed at the end of this section.

	Grade	Price
An exceptionally interesting story of the life of a very cunning fox.		
Animal Sounds. By George F. Mason. 96 pp. '48. Morrow.... The nature student uses his ears instead of his eyes. Common bird songs, the spring peeper, the cricket's chirp, animal danger signals are typical of the types of sounds described.	6	2.00
Birds		
Starlings. By Wilfred S. Bronson. 76 pp. '48. Harcourt..... The story of starlings from nesting time until the young are completely independent. The text is printed in large, clear type, and there are pictures on every page.	2	2.00
Our Bird Friends and Foes. By William Atherton Dupuy. 328 pp. '48. Winston..... A reference book for good readers.	5	1.52
Rufous Redtail. By Helen Garrett. 157 pp. '47. Viking..... This is the story of a hawk from his first experience of a rainstorm to his mating with a young redtail.	6	2.50
Conservation		
Pogo's Farm Adventure. By Jo and Ernest Norling. 46 pp. '48. Holt..... A story of soil, including irrigation, soil conservation, and beavers. An interesting story which is also well illustrated.	3	1.50
General Nature Study		
Wild Folk At the Pond. By Carroll Lane Fenton. 127 pp. '48. Day..... Includes crayfish, turtles, kingfishers, racoons and other creatures that belong to pond communities. Important plants are also described. The illustrations are authentic and informative.	5	2.00
Nature Quests & Quizzes. By Raymond T. Fuller. 64 pp. '48. Day..... The first part suggests one hundred "quests." One hundred nature questions make up the second section.	6	1.50
General Science		
Chemi The Magician. By Ruthie Duskin. 189 pp. '47. Dodd.... Ruthie Duskin, clever Quiz kid, has written this book with the help of her father, a chemistry teacher.	4	2.50
It Seems Like Magic. By Josephine van Dolzen Pease. 80 pp. '46. Rand..... How a train runs, how an airplane flies, why a boat floats, what makes an automobile go, and other explanations that children enjoy.	4	2.50
The Story of Sound. By James Geralton. 74 pp. '48. Harcourt... The answers to many questions about sound answered in simple, non-technical language. Written by an instructor of physics at Harvard University.	6	2.00
Insects		
Strange Visitor. By Edith F. Johnston. 72 pp. '47. Macmillan... This is a story about the praying mantis.	3	2.50
Our Insect Friends and Foes. By William Atherton Dupuy. '48. Winston..... A reference book for good readers.	5	1.52

	Grade	Price
Wings In The Woods. By Robert M. McClung. 251 pp. '48. Morrow	5	2.50
A book about Dan and his hunt for butterflies and moths.		

Medicine

Louis Pasteur. By Laura N. Wood. 218 pp. '48. Messner	6	2.75
The story of one of the world's great scientists whose patient experiments and painstaking research contributed vastly to modern medicine, surgical practice and industry.		
Modern Medical Discoveries. By Irmengarde Eberle. 183 pp. '48. Crowell	6	2.50
Tells about the discovery of penicillin, sulfa, DDT, plasma and atabrine.		
Women Doctors Today. By Sally Knapp. 184 pp. '47. Crowell	6	2.50
Stories of women in modern medicine. Dr. Vesta Rogers, Dr. Lauretta Bender, Dr. Edith Summerskill, Dr. Katherine Li, Dr. Katharine Elsom, Dr. Emily Van Loon, and six other biographies.		

Plants

Our Plant Friends and Foes. By William Atherton Dupuy. 290 pp. '48. Winston	5	1.52
This is a book about plants from apples to daisies. It is a useful reference book but only for good readers.		
Beginner's Guide To Wild Flowers. By Ethel Hinckley Hausman. 376 pp. '48. Putnam	6	3.50
Includes over a thousand species with an individual illustration and description for each flower.		

Science and Industry

Aluminum from Mine to Sky. By June Metcalfe. 128 pp. '47. Whittlesey	6	2.50
The evolution of aluminum through history, mining and fabrication to its present form in thousands of items in everyday use.		

Seasons

Fall Is Here. By Bertha Morris Parker and Others. 36 pp. '48. Row	1	.40
One of the Basic Science Education Series.		
Winter Is Here. By Bertha Morris Parker and Others. 36 pp. '48. Row	1	.40
One of the Basic Science Education Series.		
Spring Is Here. By Bertha Morris Parker and Others. 36 pp. '48. Row	1	.40
One of the Basic Science Education Series.		
Summer Is Here. By Bertha Morris Parker and Others. 36 pp. '48. Row	1	.40
One of the Basic Science Education Series.		

Transportation

Model Planes for Beginners. By H. H. Gilmore. 95 pp. Revised Ed. '47. Harper	4	1.50
How to build solid models of ten well-known American war planes.		
The Boys Book of Rockets. By Raymond F. Yates. 131 pp. '48. Harper	6	2.50
Tells, in stories of real adventure, of scientists first attempts		

	Grade	Price
to reach into the sky, of experiments and discoveries leading up to the knowledge now being used in rocket experimentation.		
Henry Ford. By Cy Caldwell. 246 pp. '48. Messner..... A biography of one of America's great industrial pioneers.	6	2.75
Historic Models of Early America. By C. J. Maginley. 156 pp. '47. Harcourt..... Directions for making models. Under four headings, Transportation in Early America, On Early American Farms, In Early American Homes, and In Early American Villages.	6	2.50

PUBLISHERS AND THEIR ADDRESSES

Crowell: Thomas Y. Crowell Company, 432 Fourth Avenue, New York 16, N. Y.
Day: The John Day Company, 121 Sixth Avenue, New York 13, N. Y.
Dodd: Dodd, Mead and Company, Incorporated, 432 Fourth Avenue, New York 16, N. Y.
Dutton: E. P. Dutton and Company, Incorporated, 286–302 Fourth Avenue, New York 10, N. Y.
Harcourt: Harcourt, Brace and Company, 383 Madison Avenue, New York 17, N. Y.
Harper: Harper and Brothers, 49 East 33rd Street, New York 16, N. Y.
Holt: Henry Holt and Company, Inc., 257 Fourth Avenue, New York 10, N. Y.
Macmillan: The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y.
Messner: Julian Messner, Inc., 8 West 40th Street, New York 18, N. Y.
Morrow: William Morrow and Company, 425 Fourth Avenue, New York 16, N. Y.
Putnam: G. P. Putnam's Sons, 2 West 45th Street, New York 19, N. Y.
Rand: Rand McNally Company, 111 Eighth Avenue, New York 11, N. Y.
Reilly: Reilly and Lee Company, 325 W. Huron Street, Chicago 10, Ill.
Row: Row, Peterson and Company, 131 East 23rd Street, New York 10, N. Y.
Viking: The Viking Press, Incorporated, 18 East 48th Street, New York 17, N. Y.
Whittlesey: McGraw-Hill Book Company 330 West 42nd Street, New York 18, N. Y.
Winston: The John C. Winston Company, 1006–1020 Arch Street, Philadelphia 7, Pa.

FAST-MULTIPLYING BACTERIA FOUND CONVENIENT FOR HEREDITY STUDIES

Bacteria are being found convenient organisms for the study of mutations, or sudden hereditary changes. In the number of generations they produce in a given time, as well as in the small space they occupy and the low cost of feeding them, they put rabbits and even fruit-flies completely in the shade.

Reports of two types of bacterial mutation are presented in the new issue of the Proceedings of the National Academy of Sciences. The first comes from Dr. Francis J. Ryan of Columbia University. He has found in cultures of lactic-acid-producing bacteria new strains that can get along without certain of the amino acids, or protein building-blocks, which the original ancestral species always required for living. Typical is a new strain able to get along without the common amino acid, histidine.

The other report is by Dr. E. Ruth Witkus of Fordham University. Her bacterium is a species that is normally yellow, but which has several times produced white variants which are stable, never reverting to yellow no matter how long their cultures are carried on. The curious thing is that this white mutant strain can be produced only through the cooperation of four other, and quite different, bacterial species in a mixed culture.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

2107. *Nicholas Kushta, Arlington Heights, Ill.*

2108. *George Gedroc, Chicago 17, Ill.*

2109. *Hugo Brandt, University of Md.*

2104. *J. W. Lindsey, Amarillo, Tex.*

2113. *Proposed by Walter H. Carnahan, Boston.*

Solve for x and y. (From Bowser's College Algebra.)

$$(x^6+1)y=(y^2+1)x^3 \tag{1}$$

$$(y^6+1)x=9(x^2+1)y^3. \tag{2}$$

Solution by V. C. Bailey, Evansville College.

$$\frac{x^6+1}{x^3}=\frac{y^2+1}{y} \quad \text{or} \quad x^3+\frac{1}{x^3}=y+\frac{1}{y} \quad \text{(From 1)} \tag{3}$$

$$\frac{y^6+1}{y^3}=\frac{9(x^2+1)}{x} \quad \text{or} \quad \frac{1}{3}\left[y^3+\frac{1}{y^3}\right]=3\left[x+\frac{1}{x}\right] \quad \text{(From 2)} \tag{4}$$

$$x^3+3\left[x+\frac{1}{x}\right]+\frac{1}{x^3}=\frac{1}{3}\left[y^3+\frac{1}{y^3}\right]+\left[y+\frac{1}{y}\right] \quad \text{(From 3 and 4)} \tag{5}$$

$$\left[x+\frac{1}{x}\right]^3=\frac{1}{3}\left[y+\frac{1}{y}\right]^3 \quad \text{(From 5)} \tag{6}$$

$$3\left[x+\frac{1}{x}\right]^3=\left[y+\frac{1}{y}\right]^3 \tag{7}$$

$$\sqrt[3]{3}\left[x+\frac{1}{x}\right]=y+\frac{1}{y} \tag{8}$$

$$\sqrt[3]{3}\left[x+\frac{1}{x}\right]=x^3+\frac{1}{x^3} \quad \text{(From 3)} \tag{9}$$

$$\left[x+\frac{1}{x}\right]\left[\sqrt[3]{3}-\left(x^2-1+\frac{1}{x^2}\right)\right]=0. \tag{10}$$

The first factor of (10) gives imaginary values of x.

$$x^2-1+\frac{1}{x^2}=\sqrt[3]{3} \tag{11}$$

$$x+\frac{1}{x}=\pm\sqrt{\sqrt[3]{3}+3} \quad \text{(From 11)} \tag{12}$$

$$x-\frac{1}{x}=\pm\sqrt{\sqrt[3]{3}-1} \quad \text{(From 11)} \tag{13}$$

$$x=\frac{1}{2}\left[\pm\sqrt{\sqrt[3]{3}+3}\pm\sqrt{\sqrt[3]{3}-1}\right. \quad \text{(Four values)} \tag{14}$$

$$x=\pm.72 \text{ and } \pm1.39 \quad \text{(Approximate)} \tag{15}$$

$$y+\frac{1}{y}=\sqrt[3]{3}(\pm\sqrt{\sqrt[3]{3}+3}) \quad \text{(From 8 and 12)} \tag{16}$$

$$y=\frac{1}{2}\left[\pm\sqrt[3]{3}\sqrt{\sqrt[3]{3}+3}\pm\sqrt{3\sqrt[3]{9}-1}\right] \tag{17}$$

$$y=\pm.62 \text{ and } \pm2.6 \quad \text{(Approximate).} \tag{18}$$

The seven real solutions are:

$$x=-1.38,\quad -.72,\quad -.72,\quad 0,\quad .72,\quad .72,\quad 1.38$$
$$y=-2.6,\quad -.62,\quad -2.6,\quad 0,\quad .62,\quad 2.6,\quad 2.6.$$

Solutions were also offered by W. J. Cherry, Berwyn, Ill.; Hugo Brandt, University of Maryland; Linus Guggenberger, Richmond, Minn.

Editor's note: The author gives as his solution the values of x and y given in (14) and (17), with the ambiguous sign replaced by the positive value, except it is retained in second term of (17). The approximate solution given by Messrs. Cherry and Guggenberger were: ($\pm.72$, $\pm.375$) ($\pm.72$, ±2.66) (±1.386, $\pm.375$) (±1.386, ±2.66), like signs being paired together.

2114. *Proposed by V. H. Paquet, Colton, Ore.*

A solid sphere, radius one, is to have three circular cylindrical holes drilled through it, the holes to be equally spaced on a great circle of the sphere, the longitudinal center lines of the holes to be in the plane of the great circle. What is the radius of the drill if the net volume of the holes is one-half the remaining solid part of the sphere?

Solution by W. J. Cherry, Berwyn, Ill.

Fig. 1 shows how three circular cylinders intersect under the conditions of the problem. From the volume of each cylinder we must subtract eight times the volume which we compute from Fig. 2. It will be observed in Fig. 2 that an element of volume is $xy\sqrt{3}dx$ and that $x^2+y^2=r^2$. Hence we have:

$$8V=8\sqrt{3}\int_0^r xydx=8\sqrt{3}\int_0^r x\sqrt{r^2-x^2}\,dx=-\frac{8\sqrt{3}}{3}(r^2-x^2)^{3/2}\Big]_0^r=\frac{8r^3\sqrt{3}}{3}.$$

Since there are three cylinders, the volume to be subtracted is $8r^3\sqrt{3}$.

The radius of each cylinder is r and the length is $2\sqrt{R^2-r^2}$. Since the volume of the three cylinders is $6\pi r^2\sqrt{R^2-r^2}$, the net volume of the holes is:

$$V=6\pi r^2\sqrt{R^2-r^2}-8r^3\sqrt{3}.$$

This does not include the spherical segments at the ends of the cylinders; for, under a strict interpretation of the problem, the spherical segments are not prat of the holes when we examine our sphere after the drilling has been accomplishep However an approximate value for r is indicated below for this contrary interpretation.

From the volume of the sphere we must subtract the net volume of the holes and the volume of the six spherical segments removed by the drilling. For the latter we take six times a volume of revolution:

$$6V=6\int_{\sqrt{R^2-r^2}}^{R}\pi y^2dx, \quad \text{where} \quad y^2=R^2-x^2.$$

This gives us

$$6V=2\pi(2R^3-2R^2\sqrt{R^2-r^2}-r^2\sqrt{R^2-r^2}).$$

Our final equation is

$$\frac{4}{3}\pi R^3-(6\pi r^2\sqrt{R^2-r^2}-8r^3\sqrt{3})-2\pi(2R^3-2R^2\sqrt{R^2-r^2}-r^2\sqrt{R^2-r^2})$$
$$=2(6\pi r^2\sqrt{R^2-r^2}-8r^3\sqrt{3}).$$

Now then $r\geqq\frac{1}{2}$; the sphere comes apart, as can be seen from Fig. 1. Furthermore, $r=\frac{1}{2}$ is clearly too great, as substitution will show. We seek a root between 0 and $\frac{1}{2}$; and solution of the equation yields the root $r=.3206$.
Therefore the required radius is $r=.3206$

If one interprets the problem as meaning that the material removed must be half the material remaining, then the radius will still be in the neighborhood of .32, for the spherical segments are very small.

The proposer offers a solution giving $4=.4242$.

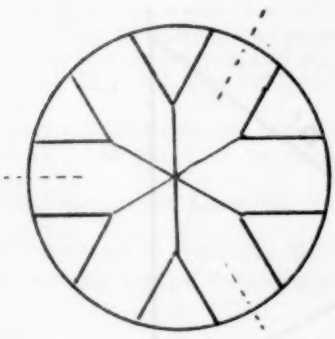


FIG. 1

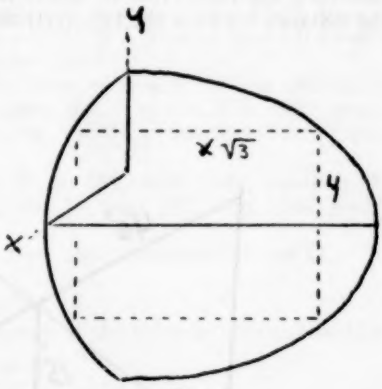


FIG. 2

2115. *Proposed by Bessie Spillman, Dobb's Ferry, N. Y.*

A triangle ABC is inscribed in a circle, diameter d. If $d^2=a^2+b^2+c^2$, then show that $\sin^2 A+\sin^2 B+\sin^2 C=2$, and that the triangle is right angled.

Solution by C. W. Trigg, Los Angeles City College

It is well-known and easily proven that $a=d\sin A$, $b=d\sin B$ and $c=d\sin C$. It follows that $a^2+b^2+c^2=d^2(\sin^2 A+\sin^2 B+\sin^2 C)$. If it be required that $a^2+b^2+c^2=kd^2$, then $\sin^2 A+\sin^2 B+\sin^2 C=K$. Now if $A+B+C=180°$, then

$$\sin^2 A+\sin^2 B+\sin^2 C=\sin^2 A+\sin^2 B+1-\cos^2 C$$

$$=1+\sin^2 A+\sin^2 B-(\sin A \sin B-\cos A \cos B)^2$$
$$=1+\sin^2 A+\sin^2 B-\sin^2 A \sin^2 B+2 \sin A \sin B \cos A \cos B$$
$$-\cos^2 A \cos^2 B$$
$$=2-(1-\sin^2 A)(1-\sin^2 B)-\cos^2 A \cos^2 B$$
$$+2 \sin A \sin B \cos A \cos B$$
$$=2+2 \cos A \cos B(\sin A \sin B-\cos A \cos B)$$
$$=2+2 \cos A \cos B[-\cos (A+B)]=2+2 \cos A \cos B \cos C=K.$$

If $K=2$, then $2 \cos A \cos B \cos C=0$, so one of the factors, say $\cos C$, is zero and $C=90°$. Then $c=d$,and $a^2+b^2=c^2$.

If $K=1$, then $\cos A \cos B \cos C=-\frac{1}{2}$, so one of the cosines is negative and the triangle is obtuse. In this case the nine-point circle cuts the circumcircle orthogonally (see American Mathematical Monthly, Vol. 45, p. 119, Feb. 1938, problem E 285). In fact, if $0<K<2$ the triangle is obtuse.

If $K>2$, then $2 \cos A \cos B \cos C$ is positive, so since the cosines of two angles of a triangle cannot be negative, the triangle is acute. 9/4 is the maximum possible value of K, obtained when the triangle is equilateral.

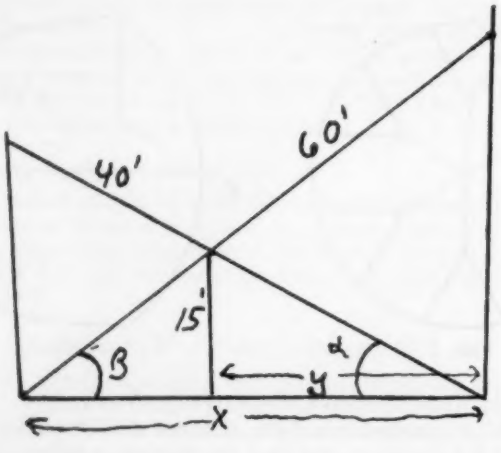
2116. *Proposed by M. Y. Woodbridge, Brooklyn, N. Y.*

Two ladders, 40 ft. and 60 ft. in length, cross in a vertical plane at a point 15 ft. above the horizontal. If the ladders rest on walls on opposite sides of a street, find by use of trigonometry the width of the street.

Solution by proposer

Despite all attempts to simplify the solution the problem of two ladders leaning against opposing vertical walls remains unwieldy when handled by purely algebraic methods. Thus the following trigonometric solution is suggested.

Let ladders 40′ and 60′ in length make angles α and β respectively with the horizontal ground and cross 15′ above the ground as illustrated. Required to find x, the distance between the two vertical walls.



Since

$$\cot \alpha=y/15 \quad \text{and} \quad \cot \beta=(x-y)/15$$
$$\cot \beta+\cot \alpha=x/15. \tag{1}$$

Also

$$x=40 \cos \alpha \tag{2}$$

and since $x=60\cos\beta$

$$\cos\beta=2/3\cos\alpha. \tag{3}$$

Substituting (2) and (3) in (1) and using the fundamental relations between contangent, sine and cosine

$$\frac{2/3\cos\alpha}{\sqrt{1-4/9\cos^2\alpha}}+\frac{\cos\alpha}{\sin\alpha}=\frac{40\cos\alpha}{15}.$$

Since α cannot be 90° in the problem we may divide through by $\cos\alpha$ and express the equation in terms of $\sin\alpha$

$$\frac{2/3}{\sqrt{4/9\sin^2\alpha+5/9}}+\frac{1}{\sin\alpha}=\frac{8}{3}.$$

And after dividing by $2/\sqrt{5}$ we have

$$\frac{1}{\sqrt{4/5\sin^2\alpha+1}}+\frac{1}{2/\sqrt{5}\sin\alpha}=\frac{4\sqrt{5}}{3}=2.9814$$

in which we now substitute

$$2/\sqrt{5}\sin\alpha=\cot\gamma \tag{4}$$

getting

$$\frac{1}{\sqrt{\cot^2\gamma+1}}+\frac{1}{\cot\gamma}=2.9814$$

or

$$\sin\gamma+\tan\gamma=2.9814. \tag{5}$$

From a table of natural trigonometric functions it is found that $\gamma=60°19'30''$ for which $\sin\gamma=90$; 2 and $\tan\gamma=2.0802$ satisfies (5). Then from (4) $\sin\alpha=.24\cot\gamma=.24(2.236)=.5366$ or $\alpha=32°27'20''$. Finally from (2) $x=40\cos\alpha=40(.8438)$ and $x=33.75$ which was to be found.

Mr. Trigg in offering a solution makes these references to this oft-recurring problem: SCHOOL SCIENCE AND MATHEMATICS, Vol. 9, p. 174, Feb. 1909, problem 131; Vol. 32, p. 212, Feb. 1932, problem 1194; Vol. 37, p. 860, Oct. 1937, problem 1498.

American Mathematical Monthly, Vol. 29, p. 181, April 1922, problem 2836; Vol. 34, p. 50, Jan. 1927, problem 3173; Vol. 51, page 592, Dec. 1944, problem E616.

Mathematics New Letter, Vol. 8, p. 65, Dec. 1933, problems 35 and 41.

2117. *Proposed by Francis L. Mikda, Aurora, Ill.*

In triangle ABC, if the angles and the sum of the sides be given show that

$$a=\frac{s\sin A}{D}$$

where

$$s=a+b+c \quad \text{and} \quad D=4\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}.$$

Solution by Max Beberman, Shanks Village, N. Y.

$$A+B+C=180° \quad \text{or} \quad \frac{A+B}{2}=90°-\frac{C}{2}$$

$$D=4\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}$$

$$=2\cos\frac{C}{2}\left(2\cos\frac{A}{2}\cos\frac{B}{2}\right)$$

$$=2\cos\frac{C}{2}\left(\cos\frac{A-B}{2}+\cos\frac{A+B}{2}\right)$$

$$=2\cos\frac{C}{2}\left(\cos\frac{A-B}{2}+\sin\frac{C}{2}\right)$$

$$=2\sin\frac{A+B}{2}\cos\frac{A-B}{2}+2\sin\frac{C}{2}\cos\frac{C}{2}$$

$$\therefore\ D=\sin A+\sin B+\sin C.$$

Now

$$aD=a\sin A+a\sin B+a\sin C$$

$$=a\sin A+b\sin A+c\sin A$$

$$=(a+b+c)\sin A=s\sin A$$

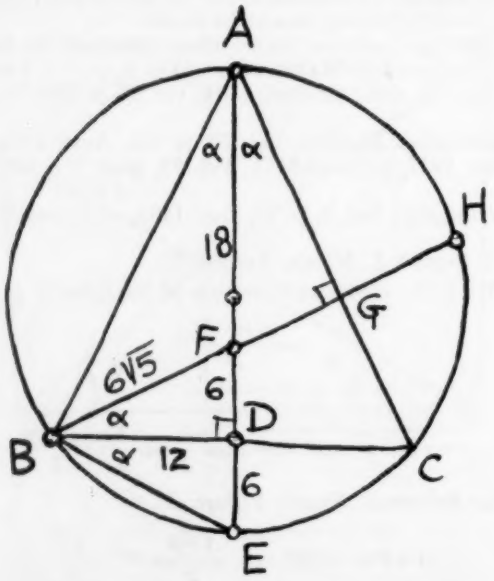
$$\therefore\ a=\frac{s\sin A}{D}.$$

Solutions were also offered by V. C. Bailey, Evansville College; C. W. Trigg, Los Angeles City College; and Nicholas Kushta, Arlington Heights T.H.S. Arlington Heights, Ill.; Hugo Brandt.

2118. *Proposed by Harvey Saffeir, Ithaca, N. Y.*

In a circle an isosceles triangle ABC is inscribed. On base BC an altitude is drawn meeting BC and D and the circle in E. From B an altitude is drawn to AC meeting AD in F, AC in G and circle in H. If $AF=18$, $DE=6$, find length of BH.

Solution by Hugo Brandt, University of Maryland



In triangles BDE and BDF, since each angle at B equals α, they are congruent and hence $DF=DE=6$, making $BD=12$, and $BF=6\sqrt{5}$.

From geometry,

$$FH \cdot 6\sqrt{5} = 18.12.$$

Then

$$FH = \frac{\sqrt{5} \cdot 36}{5}$$

$$\therefore\ BH = BF + FH = \frac{\sqrt{5} \cdot 66}{5} = 29.5152.$$

Solutions were also offered by Harvey Saffeir, Cornell University; S. R. Domen, Indiana (Pa.) S.T.C.; Margaret Joseph, Milwaukee, Wis.; C. W. Trigg, Los Angeles City College; Max Beberman, Shanks Village, N. Y.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2108, 2099. *Richard Schubert, Cicero, Ill.*

2117. *Nicholas Kushta, Arlington Heights, Ill.*

PROBLEMS FOR SOLUTION

2131. *Proposed by Daisy Caryell, Edmonton, Canada.*

By inspection show that one root of $x^3+3x=a^2-a^{-2}$ is $x=a-a^{-1}$.

2131. *Proposed by V. C. Bailey, Evansville, Ind.*

One the sides of triangle ABC equilateral triangles $A'BC$, $B'CA$, and $C'AB$ are constructed externally. Prove that

$$A'B'C' = 5/2\triangle ABC + \sqrt{3}/8(a^2+b^2+c^2).$$

2133. *Proposed by William W. Johnson, Cleveland, Ohio.*

Solve for x:

$$\left(\frac{x-a+b}{x+a-b}\right)^2 = \left(1+\frac{2x}{a}\right)^2 + \left(1+\frac{2x}{b}\right)^2 - 9.$$

This appeared as **1673** with no solution. Let's have one.

2134. *Proposed by V. C. Bailey, Evansville, Ind.*

If the sides of a triangle are in arithmetic progression and if the greatest angle exceeds the least by 90°, show that the sides are proportional to

$$\sqrt{7}+1,\quad \sqrt{7} \text{ and } \sqrt{7}-1.$$

2135. *Proposed by W. R. Warne, Alton, Ill.*

For $x^3+px^2+qx+r=0$, with roots α, β, γ, find

$$\sum \frac{\alpha^2+\beta^2}{\alpha\beta}.$$

This was problem **1830** for which no solution was offered.

2136. *Proposed by C. W. Trigg, Los Angeles.*

If $f(x)=x^3+14x^2+23x+a=0$ and $g(x)=x^3+8x^2-7x+b=0$ have two roots in common solve each equation.

DO WE TEACH BIOLOGY?

MARY THOMASINE PATTERSON
Mount Mary College, Milwaukee, Wisconsin

Biology, according to Webster's dictionary, is the study of *living* things. If that definition is correct many of us do not teach biology. Our courses often are concerned with the dead rather than with the living. How differently pupils react when use is made of the living plant or animal rather than of the specimen preserved in formaldehyde or alcohol. And our own reaction, too, is not the same.

From experience, we know it is not possible to eliminate the use of all preserved material. Indeed, such material has a vital part in laboratory work. However, isn't it true that we often use it as a matter of convenience rather than necessity? It is easier to step to the stock room and obtain what we need at the moment than to have the living animal in the laboratory when needed. Perhaps that is one reason we teach books rather than nature.

Haven't you been in a so-called laboratory where the only living things were a few fish in an aquarium and one or more sickly appearing potted plants? On the other hand, many teachers are doing a splendid job with few facilities.

One of the most functional laboratories I have visited was one in which each student was carrying on a project with living organisms. Each had been given a small aquarium and then was allowed to follow his own inclinations. And what a variety of interests were manifested in that room! Some, of course, were satisfied with caring for a couple of gold fish. But among the class were those interested in raising hydra, planaria, crayfish, snakes, daphnia, sponges, etc. There were others whose attention was given to growing plants of various types and their tanks were flourishing terraria with a variety of plants helping to make the room a place of interest for the entire student body. Needless to say, this laboratory was kept open during the entire school day and more teaching was accomplished during the noon-intermission hour than during the class hours.

The frog is perhaps one of the most widely used animals in our laboratories. We laboriously endeavor to have the pupils dissect a preserved specimen and identify the various organs—if they are identifiable after the dissection is completed. This is well, but do we make use of the living frog to the same extent? We point out the lungs and explain that it is due to their thin walls and numerous capillaries that respiration is effected. But do we, at the same time, point out the breathing movements in the living animal? Or compare them with those of a mammal?

We show the heart with the large blood vessels entering or leaving

it and explain its function as a pumping station. But do we take the time and have the patience necessary to demonstrate the circulation of blood in a fin of a fish or the web of a frog's foot?

The stomach and intestine are important and we don't neglect them. But how many of our pupils have seen the rapidity with which the frog captures its food?

How many uses could be made of living frogs in our laboratories and in how few are they found! They require more attention, of course, than the barrel of "pickled" animals in the stock room but isn't the result worth the extra time?

In teaching metamorphosis we could use many specimens that are not too hard to obtain. Even after having been a witness many times to the emergence of a moth from its cocoon and the subsequent drying of its wings, it is still a thrilling experience. And what pleasure there is in watching the eager expressions on the faces of the youngsters who are seeing the process for the first time. And cocoons are comparatively easy to find and bring into the laboratory. It is a little more difficult to bring the caterpillars into the room and watch them spin their cocoon, but it isn't impossible.

Frog eggs are easily found and with care will develop in the laboratory. The mortality rate is high but if one egg hatches into a tadpole and the tadpole develops into a frog the meaning of metamorphosis will have been impressed upon the minds of the children. Too, they will be convinced that the tail doesn't drop off.

Molting can be demonstrated with crayfish. These, too, can be collected in almost any stream. If the students go collecting the animals in the early spring they are very likely to find females bearing eggs. Following the life of these little animals is very fascinating. And what teacher wouldn't derive satisfaction from the sight of a tank surrounded by pupils watching the aerating of the eggs. When the young hatch the fate of the family is eagerly followed by every member of the class—often by non-members and teachers too!

Snakes are easily kept in the laboratory. One of the most important lessons that can be taught by these is the overcoming of fear. Children acquire their fear of animals from adults and it is a wise biology teacher who gradually overcomes the unnecessary dread of various animals. I have seen girls, who at one time turned white at the sight of a harmless snake, overcome their fear and finish the year with the care of snakes as an elective project. One of the most exciting days in our laboratory recently was the day eleven young were discovered in the tank with the adults. And more important, what a timely lesson on reproduction we were able to give that day.

Young clams will live for several years in an aquarium. How easy it is to teach the use of the muscular foot when the students can

watch the clams moving slowly across the bottom of the tank, leaving their trails in the sand. Too, the functioning of the siphons is easily demonstrated, as well as the reaction to external stimuli.

Plants are much easier to handle in the laboratory than animals and for that reason are more frequently used. In teaching the divisions of the plant kingdom the children can bring examples to class that they have located on the school campus or in the neighborhood of the school. After bringing them to the laboratory there is no need of using them for a single period and then discarding them. Mosses and liverworts can be grown in the laboratory very easily. The spores of the mosses can be sown and the gradual development of the protonemata and young plants can be followed from day to day. Interest can be added to this work by varying the conditions under which they are grown. Gemmae of *Marchantia* will grow readily with a little attention, and spores of ferns are easily obtained and grown. Living molds as well as many species of bacteria are of sound teaching value. I feel that pupils have a much better understanding of the rapidity of growth of bacteria after having grown a culture in the laboratory. All of these projects add immensely to the interest of the subject and the carrying out of them teaches more than any laboriously prepared discussion of the teacher on the life cycle of the respective plant.

Seed germination is a routine procedure carried out in most biology laboratories. But what do we do with the seeds after germination? Why not use seeds of plants that can be raised in the laboratory so the class can watch the entire life cycle. Of course, if your school has a green house there is almost no limit to the possibilities of making use of living plants.

Although most of us are not fortunate enough to have such an ideal situation we can all improve our teaching by making better use of living plants and animals in our laboratories. Then we would be teaching *biology*—the study of *living things*.

BOOKS AND PAMPHLETS RECEIVED

EXPLORING BIOLOGY, by Ella Thea Smith, *High School, Salem, Ohio.* Third Edition. Cloth. Pages xi+607. 16×24 cm. 1949. Harcourt, Brace and Company, 383 Madison Avenue, New Jersey 17, N. J. Price $3.28.

PRACTICAL SPECTROSCOPY, by George R. Harrison, Ph.D., Sc.D., *Professor of Physics;* Richard C. Lord, Ph.D., *Associate Professor of Chemistry;* and John R. Loofbourow, Sc.D., *Professor of Biophysics, of the Spectroscopy Laboratory, Massachusetts Institute of Technology.* Cloth. Pages xiv+695. 13.5×21 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y.

NEW SYLLABUS ALGEBRA, by C. O. Tuckey, *formerly Head Mathematical Master at Charterhouse,* and W. Armistead, *Head of the Mathematical School of Christ's Hospital.* With Answers. Cloth. Pages vii+201. 12.5×19 cm. 1948. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y.

AN INTRODUCTION TO MATHEMATICS, by A. N. Whitehead, *Waynflete Professor of Pure Mathematics in the University of Oxford.* Cloth. Pages v+191. 10.5×16.5 cm. 1948. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $2.00.

FREQUENCY MODULATION, by Nathan Marchand, *Consultant to New York University Cardiological Department.* Cloth. Pages xii+409. 14.5×23 cm. 1948. Murry Hill Books, Inc., 232 Madison Avenue, New York 16, N. Y. Price $5.00.

INSTALLATION AND SERVICING OF LOW POWER PUBLIC ADDRESS SYSTEMS, by John F. Rider. Cloth. Pages iv+204. 13.5×19 cm. 1948. John F. Rider Publisher. Inc., 480 Canal Street, New York 13, N. Y. Price $1.89.

FOUNDATIONS OF MODERN PHYSICS, by Thomas B. Brown, *Professor of Physics, The George Washington University.* Second Edition. Cloth. Pages xvi+391. 14.5×23 cm. 1949. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.00.

YOUR MATHEMATICS, by George E. Hawkins, and Gladys Tate. Cloth. 592 pages. 14.5×22.5 cm. 1948. Scott, Foresman and Company, 433 East Erie Street, Chicago, Ill.

CRIPPLED CHILDREN IN SCHOOL, by Romaine P. Mackie, *Specialist for Schools for the Physically Handicapped.* Bulletin 1948, No. 5. Pages iv+37. 15×23 cm. Superintendent of Documents, U. S. Printing Office, Washington 25, D. C. Price 15 cents.

INSTITUTE OF INTERNATIONAL EDUCATION. Twenty-Ninth Annual Report of the President. Paper. 14.5×23 cm. October, 1948. Institute of International Education, 2 West 45th Street, New York 19, N. Y.

FREE AND INEXPENSIVE LEARNING MATERIALS. Paper. Pages x+175. 15×23 cm. Division of Surveys and Field Services, George Peabody College for Teachers, Nashville, Tenn. Price 25 cents per copy.

BOOK REVIEWS

AN INTRODUCTORY COURSE IN COLLEGE PHYSICS, by Newton Henry Black, *Assistant Professor Emeritus of Physics, Harvard University.* Third Edition. Cloth. Pages xiv+800. 13.5×21.5 cm. 1948. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $5.00.

At first sight this new edition looks smaller than its predecessor but a more careful examination reveals that the pages are only one or two lines shorter while the initial page of each chapter is longer. Also the pages in the new edition are well filled and there are no blank pages between the main divisions. The new book contains 66 pages more than the old one. The text shows that a few topics have been completely eliminated including magnetostriction, Kirchoff's laws, and the electron microscope; others have been shortened. On the other hand the physics of the atmosphere has been greatly expanded and now fills an entire chapter instead of just a few topics in the chapter on heat measurement. The chapter formerly known as *Electric Waves* now becomes *Radio*, greatly expanded and improved. The study of crystals has been moved from the section on electricity to the section on light. Important additions have been made in the last chapter on *Structure of the Atom* to include such recent developments as the betatron, uranium fission, and chain reactions.

Other important changes include the omission of all the important reading references at the end of each chapter. A few of these are given in the appendix but many very interesting and important ones are deleted entirely. A very valuable

list of questions now follows each chapter and a new set of problems for the aid of the student and convenience of the teacher. Many of the illustrations have also been changed and improved but the book still contains numerous pages of little value to the student unless considerable teaching time is taken to explain them; e.g. the photographs of engine types shown on pages 342 and 343.

Some other changes, in the opinion of the reviewer, should have been made. The first of these is the use of the word *weight* for *mass*. Although the author gives the reference to the correct terminology he continues to use the error. In a later chapter on heat James Watt is mentioned but the watt, the unit of power, is not defined; but in the discussion of power in electricity the watt is given as the power unit, thus leading the student to an error in his history of scientific development. The volt is defined following the definition of the ampere and the ohm, instead of making the ohm dependent upon the ampere and volt. Here a fine print foot-note gives the explanation.

From its first appearance in 1935 this book has been a great help to beginning students of physics. The outstanding work of Professor Black as a teacher has been continued in his text. Students will find this book one of the most easily mastered; teachers find it easy to follow. It contains much more than the ordinary class can cover but omissions can be readily made without destroying the continuity. The new edition will continue it as one of the best books in the field.

G. W. W.

ELECTROMAGNETIC WAVES AND LIGHT, by Charles F. Meyer, *Associate Professor of Physics, University of Michigan*. First Part. Paper. Pages xi+83. 13.5 ×21.5 cm. 1948. Ulrich's Book Store, 549 East University Avenue, Ann Arbor, Michigan. Price $1.35.

The purpose of this book is to give a clear understanding of the idea of electromagnetic waves. The author starts with the long waves discussed by Maxwell and later discovered by Hertz. He shows how they originate and extend outward from the source, the magnetic vector at first being ahead of the electric vector, but soon the two fall into step. The first two chapters are an excellent study for radio men as well as for those interested in optics. Chapters three and four tell of polarized light—plane, circular, and elliptical. The diagrams are excellent and the discussions of this rather difficult topic are clear. Chapter five is on the electromagnetic spectrum, from the radio region at the long wave end to the cosmic region of very short waves. Chapter six aims to give the reader an intimate discussion of the spectrum and the methods of production and study. The book is well written, clear, and brief. A knowledge of mathematics through the calculus is desirable but not absolutely necessary. We anxiously await the arrival of Part Two.

G. W. W.

EXPLORING ELECTRICITY, by Hugh Hildreth Skilling, Ph.D., *Professor of Electrical Engineering, Stanford University*. Cloth. Pages viii+277. 14.5×21 cm. 1948. The Ronald Press Company, 15 E. 26th Street, New York 10, N. Y. Price $3.50.

This is one of the books that will attract students to the science courses. It gives a brief story of the men who have developed electricity from Gilbert to the atomic bomb. It is well written, interesting, informative, thought provoking. It tells the story of important discoveries and inventions but colors the history with many less known and interesting traits of the lives of the great men who took part in the research. Did you ever know that the students of Andre Marie Ampere made fun of him as he lectured but he did not realize it? That Cavendish was a very wealthy man but scolded his banker for bothering him about his money? That Joseph Henry had a telegraph over a mile long six years before Morse produced one? That James Clerk Maxwell, the great mathematical genius, was a witty poet and delivered "Lectures to Women on Physical Science?" This

book was written for the layman. It tells more about the scientists than about science. But it contains an account of the leading investigations in the development of electricity and its many applications, told in a very interesting manner, so that all who read it will enjoy it and learn the fundamental steps in the progress of our greatest industries. Get this book for your own library and for your school library.

G. W. W.

PRINCIPLES OF PHYSICS. III OPTICS, by Francis Weston Sears, *Professor of Physics, Massachusetts Institute of Technology.* Third Edition. Cloth. 369 pages 15×23 cm. 1948. Addison-Wesley Press, Inc., Kendall Sq. Bldg., Cambridge 42, Mass. Price $4.50.

This is the third volume of the already famous series on general physics designed for a two year course. Physical principles are first thoroughly discussed in clear and concise language, illustrated and explained by carefully constructed diagrams completely labeled, and finally mathematically treated—the ideal and practical way of teaching. The student thus gets a fairly good understanding of each process, then clinches his reasoning by applying the proper equations. In the first six chapters the principles of geometrical optics are covered and applied to the ordinary practical instruments, the eye, the camera, microscopes, and telescopes. The diagrams made up of white rays on a black background, made famous years ago by Edser, stand out clear before the student. Chapter 7 reverses the usual order by discussing polarization before interference and diffraction. Then follows a chapter each on Limit of Resolution, Line Spectra, Thermal Radiation, Photometry, and Color. Each chapter closes with an excellent set of problems covering the theories discussed. The text is entirely too advanced for the general class in physics but is an excellent reference for the better students. Those who have covered the analytics and calculus and can give the time to such a course in optics will be well repaid. This book should be in every physics library and students who have the preparation will find it excellent as a textbook.

G. W. W.

THE ATOM, by Sir George Thomson, *Professor of Physics at Imperial College, Cambridge, England.* Third Edition. Cloth. Pages vii+196. 10×16½ cm. 1947. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $2.00.

This is the third edition of the excellent little book which first appeared in 1930, then revised in 1937 to add the discovery of neutrons and positrons and the changes in atomic physics due to these discoveries. The development due to the discoveries of the atomic energy physicists and the effects upon world politics are the important contributions of this edition. Except for minor changes the early chapters stand as in previous editions. The chapters on "Atom Splitting," "Nuclear Energy" and "Some Outstanding Problems of the Nucleus" make up the new parts. These are written in the author's usual clear and explanatory manner—no mathematical equations, in fact little use of numbers. In his "General Conclusions" the author has this to say "The efforts of the nineteenth century to reduce everything to the properties of a continuous medium, and those of the twentieth to explain it by particles alone, seem equally to have failed. However distasteful the idea, we are apparently forced to admit the two on an equal footing. Somehow they are both there in the world and neither will yield. The relation between them is still a matter of the greatest difficulty and no full solution has yet been reached. In any case that can be tested by actual experiment, there is seldom any doubt as to how to use the two conceptions, and we hope that it will be possible to see them as two complementary halves of a single truth."

G. W. W.

ATOMIC ENERGY, being the four Norman Wait Harris lectures delivered in 1947 at Northwestern University, by Karl K. Darrow, *Bell Telephone Laboratories*. Pages 1–80, Illustrated. 13.8×21.3 cm. 1948. John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y. $2.00.

In the words of the author, "This is . . . a narrative of the basic facts most pertinent to the transformation of energy of rest mass into energy of motion and energy of heat which is what we mean when we speak of 'atomic energy' . . . . There is . . . only so much (about radio-activity) as seems essential to an understanding of that transformation and of the functions of the pile."

Each chapter in the book is the report of one of the four lectures and they are arranged in the order that the lectures were given. The first chapter considers the units of atomic structure taking care to distinguish elements and their atoms and emphasizing that the correct phrasing is *nuclear* and not *atomic* fission.

The second chapter comes to grips with the source of the energy that makes nuclear fission so direful. The electron-volt as a measure of the energy aspect of the nuclear change is developed and illustrated in the operation of the electrostatic generator rather than in the cyclotron.

The third chapter goes into the mechanics of transmutation considering the rules relating stability to the relative numbers of protons to neutrons in the nucleus. If neutrons are present in excess of the critical ratio the concept of electron release by a neutron to reduce that excess is used in the explanation. This is said to constitute one aspect of radio-activity. In further explanation it is said that in the nucleus of the heavier atoms the instability may be, in part, due to the long range electrostatic repulsion of protons for each other opposed by the short range nuclear attraction between them and the neutrons in the nucleus.

The last chapter proposes the question, "Why have any fissionable nuclei ever even formed? Why hasn't the earth, because of these fissionable nuclei, blown up spontaneously?" The need of slow moving neutrons to induce fission, the use of moderators such as heavy water and graphite to control neutron speed and the operation of electron absorbers to care for their excess are considered in relation to both the "pile" and the bomb. Both the energy output and the great variety of radio-active and stable isotopes that are produced by the pile are cited as recommending nuclear fission for other purposes than war time destruction.

Dr. Darrow presents his narrative without the use of mathematical formulations; at least none more involved than Einstein's mass-energy conversion equation. The exposition proceeds by the skillful use of analogy. Due caution is enjoined, however, that there are some secrets that are not military but rather shrouded in the complexities of quantum mathematics. The reader is impressed as he reads the volume that here is a very illuminating account of this only recently discovered source of vast quantities of energy. He is, however, made aware at many points of the narrative, that the last word is not being said. This presentation merits credit for its non-technical language without stooping to the rather dubious level of many lay-reader books said to be popularizations.

B. CLIFFORD HENDRICKS

ESSENTIALS OF RADIO. by Morris Slurzberg, B.S., M.A., *Instructor of Radio and Electronics, Jersey City Vocational High School and Jersey City Vocational Evening School, Trade Extension Courses;* and William Osterheld, B.S., M.A., *Instructor of Electricity and Radio, Wm. L. Dickinson High School, Jersey City,* Cloth. Pages xii+806. 15×23 cm. 1948. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $4.00.

The authors of this book have also written a book titled "Electrical Essentials of Radio" which gives basic electrical theory, making it useful for those who read this book.

Both authors are teachers of radio and electricity and they have prepared a

book which would serve as excellently as a class text as it would for private study and reference. It is obviously written by men with teaching experience for they have succeeded in writing an understandable book giving the basic theories and yet making sufficient application of these so that the student obtains a practical and working knowledge of radio. This book explains and teaches basic theory with more clarity than any of the handbooks and other similar books that are available.

Unlike other books that go as deeply even as this book into radio, the authors have carefully planned the presentation so that only a minimum of mathematics is required. Numerous examples and solutions to problems are given throughout the chapters. At the end of each chapter is a bibliography, a long list of "questions" and an extensive set of "problems." Answers to about 50% of the problems are furnished in the appendix.

The appendix includes such things as a comprehensive list of electrical symbols accompanied by a photograph of the instrument each represents. Reference lists are given to conversion factors, formulas, and charts on physical and electrical properties. The authors have prepared the most understandable method of presenting a description of the various color codes for resistance, capacitance, etc., that this reviewer has ever seen.

Anyone wishing to study radio and desiring more than a conversational acquaintance with it will find this an ideal book in which to begin the study. Those who know radio and work with it would find this an interesting book to read so as to refresh their memories on the basic theories and functions. It is gratifying to see that modern methods of teaching are finding their way into textbooks on technical subjects. No longer must one accept a "handbook" or "encyclopedia" as a textbook.

SHAILER PETERSON,
American Dental Association
222 E. Superior
Chicago, Illinois

MATHEMATICS FOR USE IN BUSINESS, by C. E. Hilborn, *Duquesne University Director of Research, W. S. Hill Company*. Cloth. Pages vii+472. 14×21.5 cm. 1948. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $3.50.

This is a textbook in business mathematics for use on the first year college level A knowledge of arithmetic, algebra and logarithms are essential. In the first section of the book the fundamental processes of arithmetic and algebra are introduced. A number of short cut methods to shorten and speed up calculations are given. Logarithms and the slide rule as a means of solving problems complete the topics of this section.

In the other sections of the book percentage, interest, both simple and compound, bank discounts, annuities of various types, bonds, depreciation, probability and the binomial theorem are among the topics which are discussed. The last chapter is entitled "An Approach to Statistics."

Explanations which precede each new type of problem seem adequate, and the number of exercises is sufficient. The amount of material offered seems to be enough for a three hour course throughout the year, but the author states that by omitting certain topics it can be adapted to a shorter period of time.

The appendix includes all of the necessary tables as well as a list of the answers for the odd-numbered problems. One other feature should also be mentioned. At the end of the fourth, tenth, fifteenth and last chapters there is a list of 100 review questions and problems over the preceding chapters. Your reviewer is of the opinion that this book is a valuable addition to the group of textbooks in Business Mathematics.

ALBERT R. MAHIN
Broad Ripple High School
Indianapolis, Indiana

HANDBOOK OF ELEMENTARY TECHNICAL MATHEMATICS, by John W. Greenwood, B.S., *Professional Engineer, Lecturer in Engineering, University of Buffalo*, and M. Irving Chriswell, Ed.D., *Instructur, Buffalo Technical High School*. Cloth. Pages vi+186. 13.5×20.5 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $2.10.

The authors say that "This handbook is primarily a text offering a preparation in mathematics for many technical fields. With the aid of supplementary material, it has been used successfully to cover a year's work in the junior year of the secondary-school curriculum on the basis of five recitations a week." The book includes algebra, geometry, trigonometry, logarithms and the slide rule. Though there are some exercises in which ability to calculate is the only requirement, many of the exercises are planned to use and to promote a technical knowledge and some knowledge of science would be a definite aid if one wishes to get the most from the study of this text. While a review of algebraic and geometric principles is included, emphasis is placed upon the applications of these subjects.

Explanations, though adequate, are somewhat limited. Besides the regular topics which are included in the twenty-two chapters the authors have included eighteen unit assignments. These include such topics as center of gravity of a steel try square, circular arc with inaccessible center, scale drawing of a floor plan, and area of an irregular figure. From this partial list of the assignments it seems evident that some technical ability is essential.

The number of exercises seems adequate. There are some optional exercises and as the author has explained supplementary work can be included. The illustrations and figures seem to be accurately drawn, and the student who uses this book should have a better appreciation of the importance of mathematics in technical work after he has completed this course.

The appendix includes the necessary tables for computations. If used only as a handbook, this should be recognized as a valuable book for the shop.

ALBERT R. MAHIN

BASIC MATHEMATICS FOR RADIO, by George F. Maedel, E.E. Cloth. Pages viii +339. 15×23 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.75.

This book is intended to supply the background in mathematics which is essential if the student is to understand radio textbooks and comprehend the technical literature relative to this subject. It is divided into five sections: arithmetic, algebra, arithmetic and algebra, plane and solid geometry and radio mathematics. Do not get the idea, however, that radio and radio principles are discussed only in the last section of the book. From the start of the book the exercises are chosen and illustrations are given in which electrical terms and radio techniques are emphasized. Notes are inserted in groups of problems to show relations of certain problems to the field of electricity and radio.

The explanations which precede each new set of exercises seem to be adequate. They are concise and relatively brief. Your reviewer is not sufficiently acquainted with radio to know whether all types of problems which are essential for the beginning radio student are included or not, but he feels that from the standpoint of mathematics the problems are well-chosen. The number of exercises after each new topic seem adequate to attain mastery of the new process.

The illustrations are of radio and electrical circuits, and they are distributed throughout the book. While some of these are a little complicated most of them are simple and a student who has studied electrical circuits will be able to understand most of them. For the student who plans to make radio his life work, this book will supply much valuable help and review in mathematics. The author does not specify the level of school for which this book should be used but it seems very doubtful whether a student who had not completed most of the high school mathematics courses would be able to master this book. It would appear that it could be used in college or technical schools to the best advantage, providing the

necessary review in fundamentals and the application of them to radio.

ALBERT R. MAHIN

MATHEMATICS: OUR GREAT HERITAGE. ESSAYS ON THE NATURE AND CULTURAL SIGNIFICANCE OF MATHEMATICS. Selected and Edited by William L. Schaaf, Ph.D., *Department of Education, Brooklyn College.* Cloth. Pages xi+291. 13.5×21 cm. 1948. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $3.50.

This book presents sixteen essays, selected and edited by Mr. Schaaf, on the nature and cultural significance of mathematics. The purpose of the author is to make available in a single book some of the outstanding literature in mathematics dealing with such questions as: what mathematics is; what it means; what it is trying to do; how mathematicians think; and, how they seek results. To reach a large body of interested laymen, the discussions are presented in language fairly free of mathematical intricacies.

The essays are arranged in general groups, each dealing with a different aspect: mathematics as a creative art; the development of mathematics; its internal structure and intrinsic nature; its relation to science and industry; and its cultural and humanistic bearings. The authors of the essays selected are all outstanding persons in the field. Among these mathematicians are George Sarton, Tobias Dantzig, J. W. N. Sullivan, G. H. Hardy, James Byrnie Shaw, E. T. Bell, C. V. Newsom, and Arnold Dresden. The editor introduces each essay with short explanatory remarks about its author and contents.

Mr. Schaaf has performed a valuable service in collecting this material and making it available in this form. He has done an excellent job of selecting materials for the purposes he had in mind. The book should prove interesting to teachers, to students of mathematics, and to laymen interested in the subject.

G. E. HAWKINS
LaGrange, Ill.

TRIGONOMETRY FOR SECONDARY SCHOOLS, by Charles H. Butler, *Professor of Mathematics, Western Michigan College of Education, Kalamazoo, Michigan,* and F. Lynwood Wren, *Julia A. Sears Professor of Mathematics, George Peabody College for Teachers, Nashville, Tennessee.* Cloth. Pages vii+360. 14.5×22 cm. 1948. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $2.60.

This text is organized into twelve chapters, the last two of which deal with spherical trigonometry. The first four chapters present the trigonometry of the right triangle and the fifth contains a discussion of mil and radian measure. The definitions of the functions of the general angle are first considered in chapter six. Graphs and line values of the function form the subject matter of chapter seven. The eight fundamental identities previously established for acute angles are generalized in chapter eight and the other basic identities are also considered. Chapters nine and ten present the theory of oblique triangles and provide practice in applying it to the solution of problems. The appendix contains descriptions of the instruction and use of certain simple mathematical instruments. Both four and five place tables are provided, the former being used for all illustrative computations. Answers are supplied for all the odd numbered problems and for some of the even numbered ones.

Throughout this text the emphasis is on the development of computational skill guided by the intelligent use of approximate numbers. The remarkably clear and comprehensive discussion of approximate computation which appears in chapter two is one of the outstanding features of the text. It is worth noting that the rules set forth here are adhered to in all subsequent calculations. The work on logarithms is effectively introduced and considerably enhanced by a preliminary consideration of the scientific notation.

The authors have made every effort to minimize the effect of any deficiencies which may exist in the student s previous training. The explanations are framed

in clear and simple language and they are remarkably complete and well illustrated. New concepts are built up from first principles whenever possible. When it is necessary to build upon knowledge gained in earlier courses an inventory test is usually provided to survey this knowledge. There are six such tests strategically placed throughout the text.

It should be noted that certain topics receive relatively little attention. Among these are: trigonometric equations where only 23 very simple practice exercises are given, and inverse functions where graphs are not shown, principal values are not defined and very little manipulative opportunity is provided. Chapter ten entitled "Making Use of Oblique Triangles" offers only 34 problems for solution. These problems are well chosen but some teachers may feel that supplementary problems are necessary to develop more adequately the possibilities of the formulas derived in the preceding chapter. This text does not consider complex numbers or the slide rule.

Teachers who believe that the approach to high school trigonometry should be through a study of the right triangle and that the principal objective is the development of computational skill will find this text well suited to their purpose. The fundamental ideas are developed in accordance with the sound pedagogical principles expounded by these same authors in this notable text on the teaching of secondary mathematics.

FRANK B. ALLEN
LaGrange, Illinois

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NATIONAL BOYS AND GIRLS WEEK will be observed in hundreds of communities throughout the United States and Canada from April 30 to May 7, 1949. The celebration will mark the 29th annual observance of this important youth event.

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